IMPROVED PAINT REMOVAL TECHNIQUE

to

WARNER ROBINS AIR LOGISTICS CENTER
DIRECTORATE OF MAINTENANCE
AIRCRAFT DIVISION
ALC/PPWMA

April 25, 1978

FINAL REPORT

on

IMPROVED PAINT REMOVAL TECHNIQUE

to

WARNER ROBINS AIR LOGISTICS CENTER
DIRECTORATE OF MAINTENANCE
AIRCRAFT DIVISION
ALC/PPWMA

April 25, 1978

by

James F. Mank, Richard J. Dick
Herbert C. Abrams, and Louis J. Nowacki

F09603-77-A-0708
Delivery Order No. 0001

BATTELLE
Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201

Battelle
Columbus Laboratories

April 25, 1978

Mr. Carl Craft
MABEE
Warner Robins Air Logistics Center
Robins Air Force Base, Georgia 31098

Dear Mr. Craft:

F09603-77-A-0708
Final Report

Ten copies of our Final Report on your research program "Improved Paint Removal Technique" are enclosed. We are also sending the original in case you wish to run additional copies.

We appreciate reviewing the preliminary draft of the report with you and Mr. Harold Scott during our visit to Warner Robins on April 20, 1978. Your comments were very valuable to us in revising the Draft to produce the Final Report. We have certainly enjoyed working with you on this important program.

Very truly yours,

Louis J. Nowacki
Macromolecular Science
and Technology Section

LJN:tam

Enc. (10)

cc: Mr. Harold Scott
MASE
Productivity Enhancement Office
Warner Robins Air Logistics Center
Robins Air Force Base, Georgia 31098

TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

IMPROVED PAINT REMOVAL TECHNIQUE

by

James F. Mank, Richard J. Dick,
Herbert C. Abrams, and Louis J. Nowacki

INTRODUCTION

Various air bases are charged with the responsibility for repainting aircraft. Warner Robins Air Logistics Center, for example, repaints the C-130, C-141, and F-15. The repainting is for corrosion protection; and of secondary importance for aesthetic value.

Since about 1971, the Air Force has been using polyurethane finishes applied over polyurethane or epoxy primers. These coatings are more difficult to remove with chemical strippers than older acrylic-type aircraft finishes. Consequently, special strippers had to be selected and approved under Technical Order 1-1-8. The approved proprietary strippers (at the time of this writing) are as follows: phenolic type; Turco 5292 and 5351, Pennwalt 739A and 768A, B-and-B 1567, and Intex 8562; nonphenolic types are Turco 5873, Eldorado PR-3400, and Inland AP 599.

Stripping of the polyurethane finishes is a difficult task. Consequently, the Air Force established a program at Battelle's Columbus Laboratories (BCL) to study the latest state of the art in aircraft paint stripping with the objective of providing a technical plan for improving the aircraft depaint process by using best available equipment, materials, and techniques.

The study procedure consisted of three major steps as follows:

Step 1 - Visit to Warner Robins ALC Corrosion Control Facility (B-110) to review existing methods and techniques and establish a baseline for evaluation of proposed equipment and materials.

Step 2 - Information Gathering Phase--research proven depainting materials and equipment through telephone contacts and travel to other bases (Air Force and Navy), commercial aircraft companies, and manufacturing firms.

Step 3 - Determine the most effective means for improving the depaint process providing performance specifications and an economic evaluation of the recommendations.

While the program was in progress, Robins and BCL personnel agreed mutually to add some limited laboratory evaluations of paint strippers to the study. The objective of this work was to compare efficiency of selected phenolic and non-phenolic stripping chemicals, and make brief examinations of mechanical methods for stripping paint from aircraft.

The following sections of the report describe the work done, present a summary of conclusions reached on the basis of the study, and present a plan for improving the aircraft paint stripping process.

SUMMARY AND CONCLUSIONS

The project was initiated with a brief visit to Robins Air Force Base to review their aircraft paint stripping operation. After that project initiation visit, Battelle contacted commercial airlines, aircraft mnaufacturers, military bases, contract stripping companies, and stripping chemical manufacturers to determine what the state-of-the-art is in the field of stripping paint from aircraft. Many personal visits to stripping facilities were made to get first-hand information from the people involved with stripping aircraft and to see the actual stripping facility. A summary of the information obtained from these contacts is provided in the appendix of this report.

The complete stripping of a C141 at Robins Air Force Base and the partial stripping of a KC-135 at Tinker Air Force Base were observed. The intent was to identify specific items and practices in the Warner Robins ALC operation that could be improved in order to decrease the amount of time required to strip an aircraft and therefore increase throughput.

It was concluded that Warner Robins is essentially up with the state-of-the-art of airplane paint stripping that has been observed at other stripping facilities.

The study has shown that methods used by the various air bases are basically the same as those used elsewhere. Differences that exist are of a minor nature and none can be categorically adopted by the Air Force to advantage. These differences may be summarized briefly as follows.

Equipment and facilities differ from place to place. Equipment differences include scaffolding, "cherry pickers", power ladders, stacker cranes, and other devices to promote easy access to work surfaces by the labor force. None of these assists provide obvious advantages over the work platforms used by Warner Robins. Nevertheless, this plan suggests changes in Warner Robins' work platforms for improving efficiency.

Differences in operational techniques include slight differences in stripper application, amount of agitation of strippers, time before first removal, way wash water is used, etc. No one procedure can be identified as superior to the others. Basically, the operational procedures used are largely a matter of individual preferences, and have resolved through use under localized conditions.

The same stripper materials are commercially available to all stripper installations. However, the Air Force is limited to the use of strippers approved under TO 1-1-8. There are differences of opinion regarding their relative effectiveness, but it is generally concluded that the relative strengths are (1) acid type, (2) phenolic type, and (3) non-phenolic type. Acid type is ruled out by the Air Force because it promotes stress corrosion cracking of stainless steel. However, it might be used advantageously but with care in some localized trouble spots. There can also be advantage in using the best phenolic strippers in place of non-phenolic where arrangements for proper disposal of used stripper can be made.

There are variations in employment of the labor force from place to place. These include using the same workers to strip and repaint aircraft (with upgraded job classification for stripping), and the extreme of paying by the job and working around the clock until the job is done. Adoption of these methods (employed elsewhere) are of doubtful value to the Air Force. Nevertheless, some potential for more effective use of labor force has been identified and incorporated into the plan.

The objective of the study was to develop a plan which would use proven methods observed elsewhere for increasing stripping efficiency by the Air Force, and show the economic justification for adopting the changes. Had such methods been identified, the proven savings would have been compared with estimated cost of making the change, and the payoff calculated. Since

methods used elsewhere do not offer proven advantages to the Air Force, this method could not be used for developing a plan. Consequently, the plan, which is a part of this report, is based on changes which have been identified as offering potential for increasing efficiency at Robins Air Force Base, but which have not been proven in use. Payoff is based strictly on estimates, and not on proven experience. Additional study is mandatory before making decisions regarding any substantial investments to incorporate the plan. Consideration must be given to worker motivation since changes suggested are designed to increase worker output. The plan describes rearrangements in personnel assignment, and various changes in equipment and operational procedures at Robins AFB that are expected to result in a decrease in the time required to strip an airplane. The areas of suggested modifications are:

(1) Rearrangement of personnel work assignments.

(2) Redesign of the overhead, stabilized work platforms; movement of controls from outboard side to inboard side; stripper, and water supply line for each worker; and more room for each worker to operate.

(3) Minor redesign of the tail staging to provide wider catwalks for improved safety and working room, and stripper and water services for each worker.

(4) Installation of a trench under the aircraft to improve working room.

(5) Installation of lights under the wings to improve visibility.

Brief investigations were done on alternative non-chemical methods of stripping paint. These included abrasive blasting, water jet blasting, ultrasonics, and heat. It was concluded that none of these methods are realistic alternatives to chemical stripping because they are expected to be slower and more expensive than chemical stripping or introduce a substantial risk of damaging the aircraft's skin.

A concept session was held at Battelle to determine what mechanical aids might be used to remove partially loosened paint. The session resulted in brush concepts essentially similar to what Warner Robins has tried in the past. Powered mechanical agitation or paint

removal aids are used at only one of the stripping facilities that were contacted. The general feeling at most facilities is that powered brushes are no more efficient than hand brushes for removing loosened paint and, therefore, are unnecessary. In addition, most personnel involved with stripping believe that powered devices capable of removing tightly adhering paint are too aggressive and may easily damage the plane's skin. For these reasons it was concluded that powered agitation devices would add little to the Warner Robins operation and, therefore, were not investigated any further.

Several chemical strippers were obtained from leading suppliers of chemicals for removing paint from aircraft. These were compared in the laboratory by simple spot testing to measure relative efficiency of phenolic and non-phenolic strippers. Conflicting reports had been heard regarding efficiency of the phenolic and nonphenolic types.

The lab tests showed that the phenolics as a class were more effective than the non-phenolics as a class (under the particular test conditions). However, this conclusion must be drawn with reservations. There were some reversals in results. Also, it is obvious that the particular paint sample used for testing effected results obtained. Therefore, one can simply state that there are wide differences in efficiency of strippers, and results vary according to conditions. Consequently, good procedure would be to make preliminary checks with several strippers on aircraft scheduled to enter the stripping facility. In this way, the best stripper might be selected in each case.

DISCUSSION OF PROGRAM TO IMPROVE AIRCRAFT PAINT REMOVAL

The program to improve aircraft paint removal followed a Statement of Work which described as the objective "to provide a technical plan for improving the aircraft depaint process through the use of the latest state-of-the-art equipment and/or materials". This was to be accomplished by researching proven depainting materials, equipment, and methods through extensive travel to military depainting facilities, commercial aircraft companies, and manufacturing firms.

The BCL approach was to first visit Robins and Tinker Air Force Bases to obtain overviews of their depainting operations. This was followed by extensive travel to (1) other air bases including Navy facilities, (2) commercial airlines, (3) companies who strip paint from aircraft on a contract basis, (4) aircraft manufacturers, and (5) major suppliers of chemical strippers. Other contacts were made by telephone for additional gathering of information and to determine if visits would be worthwhile. The information gathered from these visits and telephone conversations is in the Appendix of this report.

After much of the information had been gathered (as described above) follow-up visits were made to Robins AFB to follow the complete stripping of a C 141 aircraft and to Tinker AFB to follow the partial stripping of a KC 135 aircraft.

By mutual agreement between the Air Force Program Monitor and BCL personnel, a limited amount of laboratory work was carried out to compare the depaint stripping efficiency of phenolic and nonphenolic strippers. A brief investigation of several non-chemical methods of removing paint was also done in the laboratory and through discussions with knowledgeable people. All of this work is described in subsequent sections of this report.

Aircraft Paint Removal at Robins Air Force Base

Warner Robins ALC has paint/depaint responsibility for the Air Force, prepares material Tech Orders in conjunction with Wright-Patterson

AFB, and performs a substantial portion of the total Air Force paint/depaint work. They recognize the need for a simple depaint operation because low labor rates restrict the labor pool to poorly skilled personel. In general, it would be desirable to use less toxic materials and substitute mechanical procedures that would speed the paint stripping operation because the present operation presents problems as a result of EPA and OSHA effluent and air quality requirements. In addition, EPA and OSHA regulations are expected to be stricter in the future.

The ultimate goal of the aircraft paint/depaint program is corrosion control, but repainting is implemented long before corrosion is apparent. In practice, paint/depaint is performed when 60 percent of the aircraft's coating is deteriorating by chalking, peeling, etc. (about every 4-6 years depending on service). The old acrylic type aircraft paint may last for 2 years while the newer urethanes may have an acceptable service life of up to 6 years.

Warner Robins removes paint from aircraft according to the paint removal procedures described in T.O. 1-1-8, Application of Organic Coatings, Aerospace Equipment. The depaint procedure as generally outlined in T.O. 1-1-8 consists of the following:

(1) Wash to remove oil, grease, surface contamination
(2) Allow to dry
(3) Mask with aluminum tape (3M-425) and aluminum stripper paper and remove small components for individual stripping operations.
(4) Apply stripper by spray (flowed on rather than atomized) and hold for 30 minutes
(5) Scrub with stiff, fiber-bristle brush
(6) Apply second coat of stripper and hold for 15-20 minutes
(7) Agitate with brush
(8) Squeegee all loose coating
(9) If not clean to bare metal, repeat steps 6 through 8
(10) Hose down with water 120-140 F and 80-90 psi
(11) Wash with MIL-C-25769 alkaline cleaner
(12) Apply corrosion treatment (for etch) MIL-C-38334 (phosphoric acid, alcohol/water) and hold for 5-10 minutes

(13) Scrub with brush and rinse with much water (140 F)

(14) Apply Alodine 1200 brightener (MIL-C-5541) while metal is still wet

(15) To paint shop.

In practice, some of the paint is difficult to remove so additional stripper is sprayed on and brushed several times. Difficult areas include engine housings, under surfaces of wings, belly and decals.

The stripping operation is performed on the C130, C141, and F-15 by three crews totaling 68 men (35 day, 20 swing, and 13 night). However, the crew that does the actual stripping work on a plane consists of 16 day, 10 swing, and 10 night shift personnel. A C141 is completely washed and made ready for depainting in one 8-hour shift by a crew of 20 men. Stripping is usually accomplished in 6 to 8 shifts.

The approved paint strippers in T.O. 1-1-8 are as follows: (a) phenolic types: Turco 5292 and 5351, Pennwalt 739A and 768A, B-and-B Chemical 1567, and Intex 8562, and (b) nonphenolic types: Turco 5873, Eldorado PR-3400 and Inland AP 599.

Several strippers are available for use at Warner Robins to accomplish the paint removal.

(1) Turco 5873 (ammoniated)

(2) Eldorado PR-3400 (Methylene chloride with 5 percent ammonium hydroxide)

(3) Inland Chemical AP 599 (same as PR-3400 but with perchlorethylene and methanol, etc).

(4) Intex 8562 - methylene chloride plus about 14 percent phenol ("Hottest" of four compounds).

A recent tech order prohibits the use of aluminum wool except on center wing area.* This may add time to the stripping operation. An acceptable replacement is needed. Also needed are scrappers which will hold an edge, particularly in removing decals. Paint is difficult to remove on the underside of wings and horizontal stabilizers and not-easily-accessible wheel wells. Mechanical brushes are available but have not been well received by the work crews.

Two major innovations have been introduced to the C130 and C141 stripping operation at Warner Robins over the past several years. These are (1) stabilized work platforms which provide working area access to all elevated parts of the aircraft, and (2) common wing staging which

* This restriction has been lifted for Depot use only at WRALC (through a letter authorization).

permits access to the underwing areas of C141 and C130 without modification of staging. A total reduction in work time of 25-30 percent is reported to have resulted from their implementation.

Observation of Start-to-Finish Stripping of a C141 Aircraft at Robins Air Force Base

Personnel from BCL's Equipment Development Section (Mechanical Engineering) observed the C-141 paint stripping operation from the time the plane was partially masked to the time when it was completely stripped and ready to be pulled out of the stripping hanger. A meeting was held on the day after the stripping was completed to discuss Battelle's observations with Warner Robins personnel.

Stripping Procedure

Warner Robins ALC was running a three-shift stripping operation on the C-141. The day shift (approximately 8:00 am to 4:00 pm) was responsible for the fuselage. The swing shift (4:00 pm to 12:00 midnight) and the owl shift (12 midnight to 8:00 am) were each responsible for stripping one wing of the aircraft. Each shift worked on its section of the plane until that section was essentially completely stripped. At that point all or part of the shift would move to other sections of the plane to do spot stripping as required.

The plane was moved into the stripper hanger during swing shift at about 11:00 pm, January 9. The plane was not washed prior to masking and stripping which seems to be a reasonable approach unless the aircraft is unusually dirty. It would appear that a prewash before stripping would serve no useful purpose except in areas where dirt or grease is so thick that it forms a barrier over the paint that the stripper cannot penetrate. In addition, a wet plane should probably be allowed to completely dry before the stripper is applied so the stripper's effectiveness is not reduced.

A five-man crew partially masked the right wing during the owl shift on January 10. The owl shift's masking activity was not observed.

The January 10 day shift working on the plane consisted of 16 men. The day shift started by masking the fuselage. The masking process

appeared to progress very well and was completed in about 2 hours (i.e., by 9:30 am). The only problem area noted was that the men in the overhead work platforms had minor difficulty working the platforms in close to the fuselage and wing intersection point so they could reach areas to be masked. The problem wasn't serious and didn't slow the men up appreciably.

During the stripping operation it was noted that the 16 men on the day shift each had assigned areas on the fuselage on which to work. The assignments were as follows:

2 men on the nose

2 men aft of the nose on the floor (one on each side)

2 men on the wheel fairings and fuselage area under the wings (one on each side)

2 men aft of the wheel fairings on the lower fuselage (one on each side)

4 men on the tail section (two men on each side on the elevator catwalks)

4 men on the top fuselage (two men in each of the two overhead baskets).

The first coat of stripper application to the fuselage started about 10:00 am and was essentially finished by 10:45 am. The stripper was pumped directly from barrels using air-driven Graco barrel pumps. Spray wands, approximately 8 feet long were used to apply the stripper. The application equipment appeared to be adequate. The wands were of adequate length to reach under the belly of the fuselage and under the tail.

The stripper used on the plane was a Turco 5351 methylene chloride with phenol. Normally the procedure is to use a non-phenol stripper for two or three coats. A phenol stripper is then used on spots where the non-phenol material does not work well. The reason the Turco 5351 stripper was used on this plane from the start was because no non-phenol stripper was available at the time.

Application of the first coat of stripper was essentially completed by 10:45 am. The men took a break to allow the stripper to work. After the usual stripper dwell time of between 30 and 40 minutes it was getting close to lunch (11:45 am) so the stripper was left on the plane until after lunch (12:30 pm).

Immediately after lunch (12:30 pm) the workers began to remove the stripper from the aircraft and finished around 1:10 pm. The bulk of the stripper was brushed off the plane and areas such as decals, tough paint spots, etc, were brushed and scraped somewhat more aggressively. The paint on most of the fuselage was completely removed down to bare metal by the first coat of stripper. Exceptions were decals, paint on the landing gear housing fairings, the petal doors, and the belly of the plane. These areas are frequent field maintenance areas and the type of paint applied is not strictly controlled often making stripping slow and difficult.

The entire fuselage except for the tail was sprayed with water after the excess stripper had been brushed off. The tail was squeegeed only. A second coat of stripper was applied immediately after the plane was cleaned. The second coat of st ipper was applied to most of the plane by 2:00 pm. The men then took an unscheduled break for 45 minutes to allow the stripper to work. At 2:45 pm a scheduled afternoon break was taken.

At 3:00 pm, after the afternoon break, the plane's fuselage was completely hosed down. By 3:30 the plane had been completely hosed off and the men were cleaning up the area in preparation for the change of shifts. About 60-70 percent of the plane was stripped at this time.

The swing shift consisted of 16 people and they all worked on the left wing. Normally the number of people on the shift was reported to be about 8-10 people. However, because of the weather conditions and the fact that otner cleaning jobs were unavailable, all the people were assigned to the stripping hanger. The full crew started masking the left wing about 4:30 pm and they were finished by 6:00 pm when they took their first scheduled break. After the break at 6:15 pm, stripper was applied to the wing. Three people were used to apply the stripper, two over the wing in a basket, and one under the wing. After the stripper was applied, the entire crew waited for the stripper to work for 30 to 40 minutes before brushing it off the plane.

It was reported the next day that the swing shift put on a second coat of stripper after 7:00 pm and had removed all the paint except for a few localized tough spots from the left wing by the end of their work period. The owl shift, also at a reported crew level of

16 people, applied two coats of stripper to the right wing so it was ready to be spot stripped by the morning of January 11.

On the morning of January 11 the fuselage was approximately 30 to 40 percent covered with stripper in various areas, particularly on the lower parts of the belly, and the tail cargo door areas. The airplane was still completely masked. However, masking was being removed from the tail section. The cargo doors and the nose wheel still retained paint which would not come off. The underbelly aft of the nosewheel almost to the cargo door area also had paint which was not removed. The entire day was spent spot stripping the fuselage.

At 10:00 pm that evening the swing shift was demasking and spot stripping the left wing and engine pods. The airplane was completely stripped and had been moved forward so that the engine pod access doors could be opened for water flushing prior to delivery of the airplane.

Sixteen people were again assigned to the depainting of the airplane on the swing shift. Consequently, their utilization was less than optimum while they waited for the paint stripper to react with the paint. At the beginning of the shift, however, utilization of people was nearly 100 percent.

The airplane had been stripped quite rapidly, almost completely on the first day, so the foreman characterized the airplane as being easy to strip. The general foreman expects the next three airplanes to be more difficult to strip because the non-phenol stripper will be available.

It was reported that the stripping operation had gone exactly as planned. Each shift had done the work that had been expected and had done it on schedule. The airplane was actually in the area only 48 hours or 6 shifts which seemed to be a reasonable amount of time. It was reported that the stripping time often takes 8 shifts when a non-phenol stripper is used. Fifteen to 16 drums of phenol stripper were used and an average of two coats were applied to the airplane. The foreman said that they generally use 30 drums of non-phenol stripper. It appears that if a phenol stripper is permitted for normal use, the material requirements could be cut in half and the stripping time could be substantially reduced.

Observations

The depainting of airplanes at Robins Air Force Base looks as efficient as any operation observed on other military bases or at a commercial operation, other than perhaps the overlapping of workcrews which could result in higher productivity.

Much effort was taken to protect cockpit windows. The window surfaces were completely covered with tape strips and the frame around the windows was then hand stripped (Figures 1 and 2). A secondary sheet of aluminum masking paper was then taped over the entire window area (Figure 3). It was noted that the tape was difficult to remove from the windows when stripping was completed. A precut sheet of paper could be taped to the window around the edges only and should provide adequate protection in view of the care in which stripper is applied around the frame.

Two men are assigned to each overhead stabilized work platform. At least part of the reason is for safety. The two platforms also cover a large area of the plane. It was observed that the elevators, or platforms as they are called, require a driver. The platforms are square (approximately 9 feet x 9 feet) and the controls are located on the side away from the plane fuselage (Figure 4). This arrangement requires that one man operate the controls while the second applies stripper or rinses the plane. To an extent, the same arrangement exists during stripper brushing. It may be advantageous to construct a rectangular-shaped platform with the long side parallel to the longitudinal centerline of the plane. The platform dimensions can be made whatever is necessary to allow both men working room next to the aircraft. The controls could be moved from the outboard side of the platform to the inboard side which is nearest the plane's fuselage. This would allow either worker to drive part time and still do useful work (Figure 5). In order to provide extra versatility the platforms could be made long enough so occupants can reach all surfaces on the tail under the horizontal stabilizer (Figure 6). If adequate vertical clearance exists the entire tail section can then be done by workers in the platforms if the tail staging should happen to break down.

The existing tailstaging also requires that the second man apply stripper or rinse the plane. The controls are located so the operator must walk along the catwalk away from his work station to the pivot and in order to move the catwalk. The controls might be relocated for easier access.

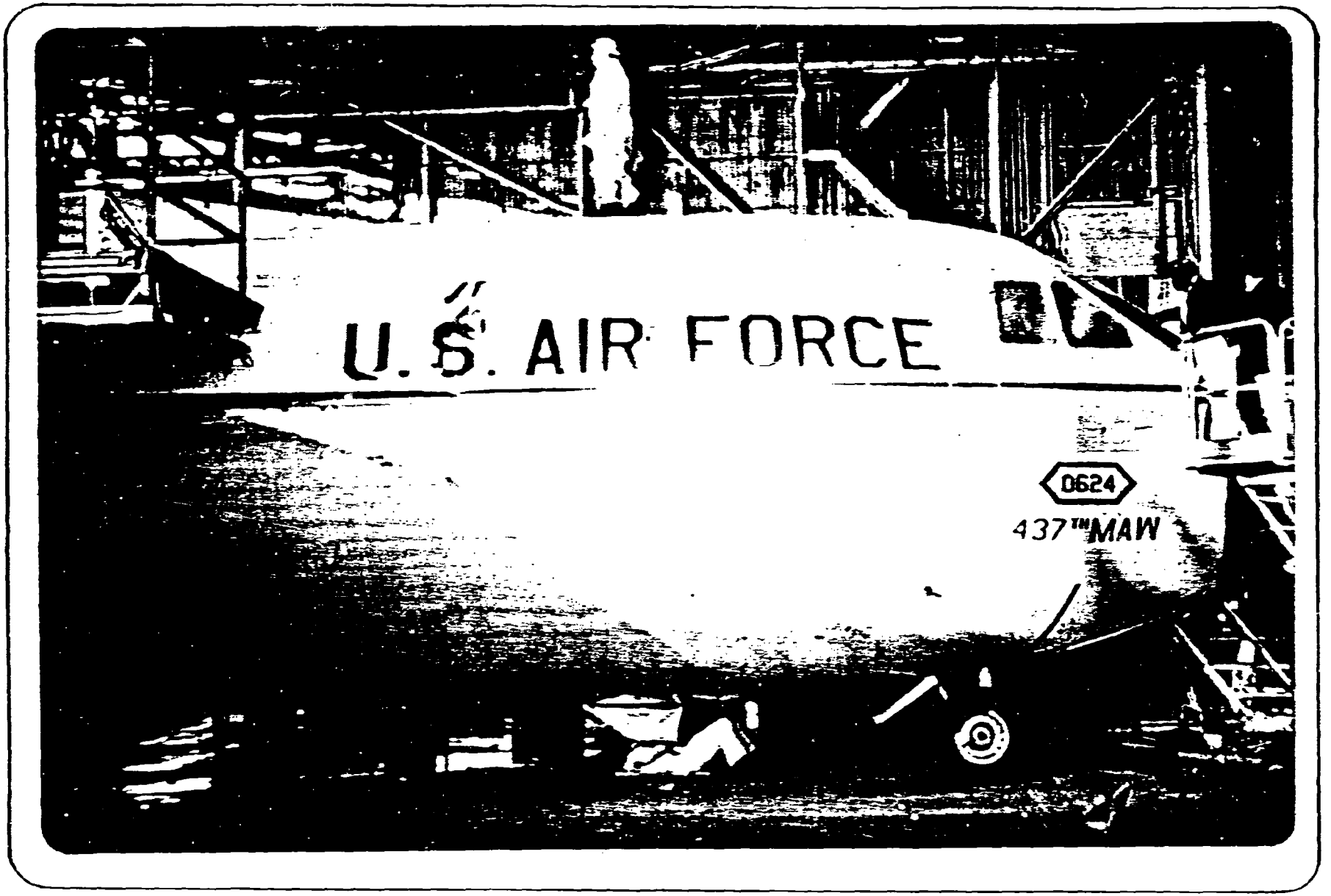


FIGURE 1. NOSE AND FORWARD FUSELAGE MASKING

FIGURE 2. COCKPIT WINDOW FRAME STRIPPING

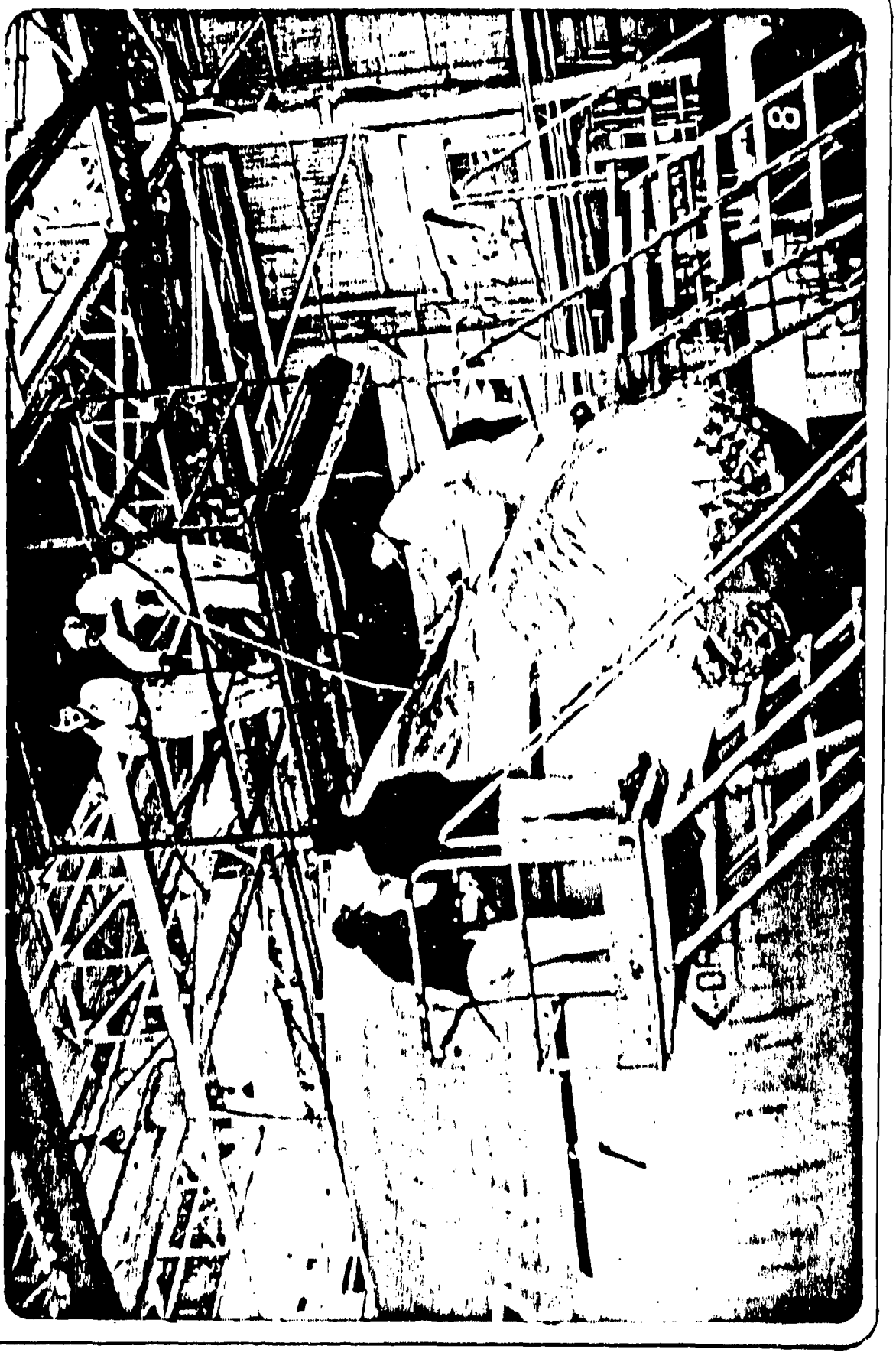


FIGURE 3. COCKPIT WINDOW MASKING

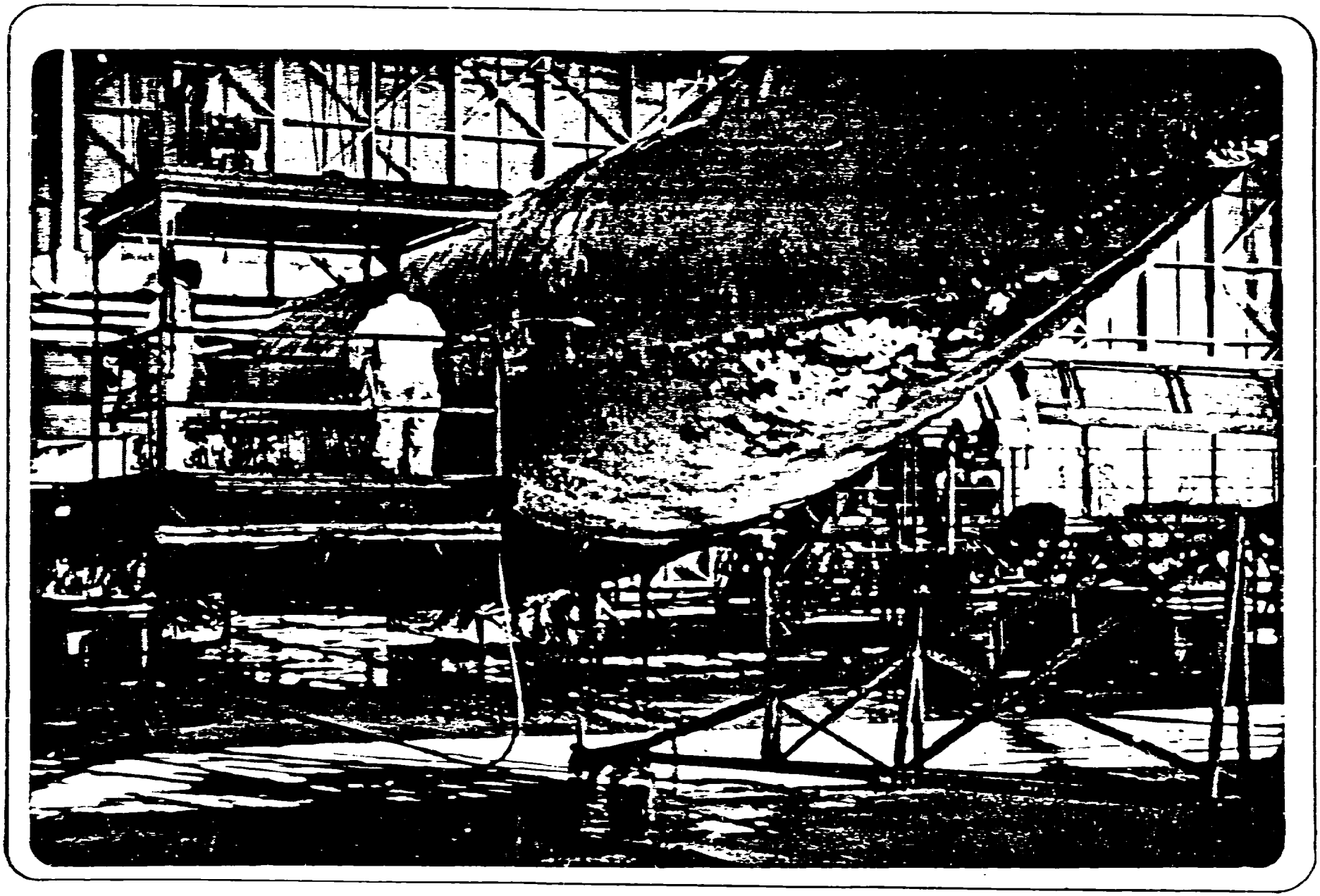


FIGURE 4. STABILIZED WORK PLATFORM

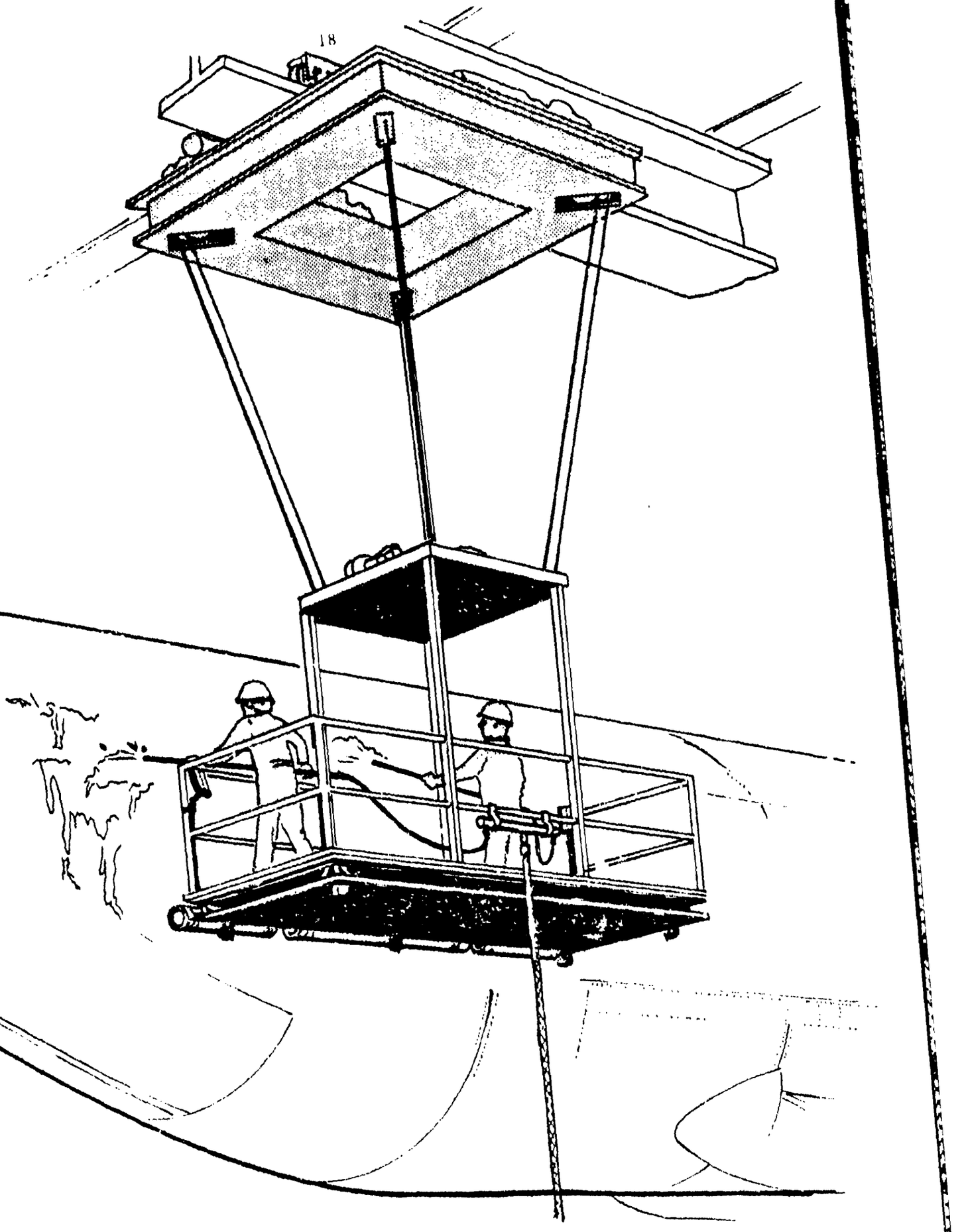


FIGURE 5. MODIFIED STABILIZED WORK PLATFORM

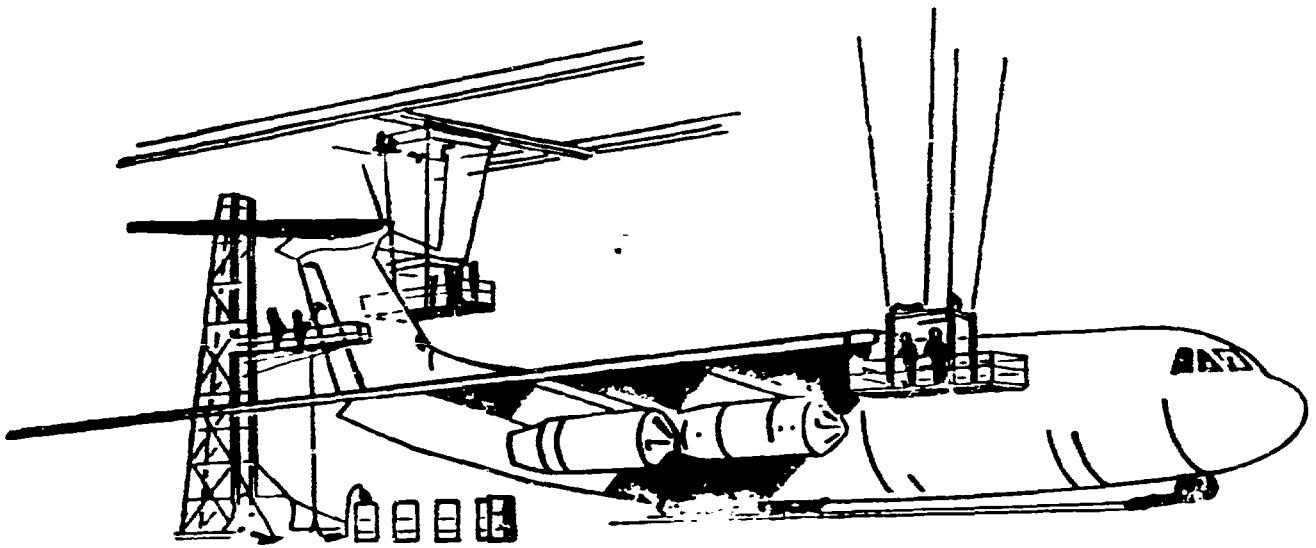


FIGURE 6. STABILIZED WORK PLATFORM AND TAIL STAGING

Permanent tail staging as an alternative with a number of fixed level decks would eliminate the need for an operator. However, the men would have to move from one work level to another. The mobile catwalk approach provides the worker transportation in addition to a work platform. The catwalk did seem narrow. Widening the catwalk might improve efficiency and allow maneuvering room for the men.

The men in the platforms and on the catwalks also had to occasionally wrestle with the hoses that hung to the ground. Hoses could be attached to a manifold block on the framework instead of simply hanging over the safety railings. This would also allow the hose to tee off at the basket to provide both workers with stripper and water lines.

Men working the belly of the plane were forced to work from creepers because of the small clearance between the C141 and the floor (see Figure 1). This appeared to be an extremely difficult work location. Paint removal on the belly is further complicated because it is a field maintenance area and often has paint applied in the field which is difficult to remove. A trench could be dug under the fuselage as shown in Figure 7, from just aft of the nose wheel to the point where the rear fuselage begins to curve upward near the tail. A trench will provide better work access and improve working conditions under the plane.

It was also noted that the workers down on the ground were not able to apply stripper while the men above them were applying it because of the possibility of their being sprayed with stripper. During the time when stripper is being applied to the top of the plane it might be advantageous for the floor crew to move under the wing areas and do some masking.

Most stripping facilities that BCL personnel visited use 55-gallon drums as supply tanks and air-driven barrel pumps to remove the stripper from the barrels. Warner Robins uses this same approach. When

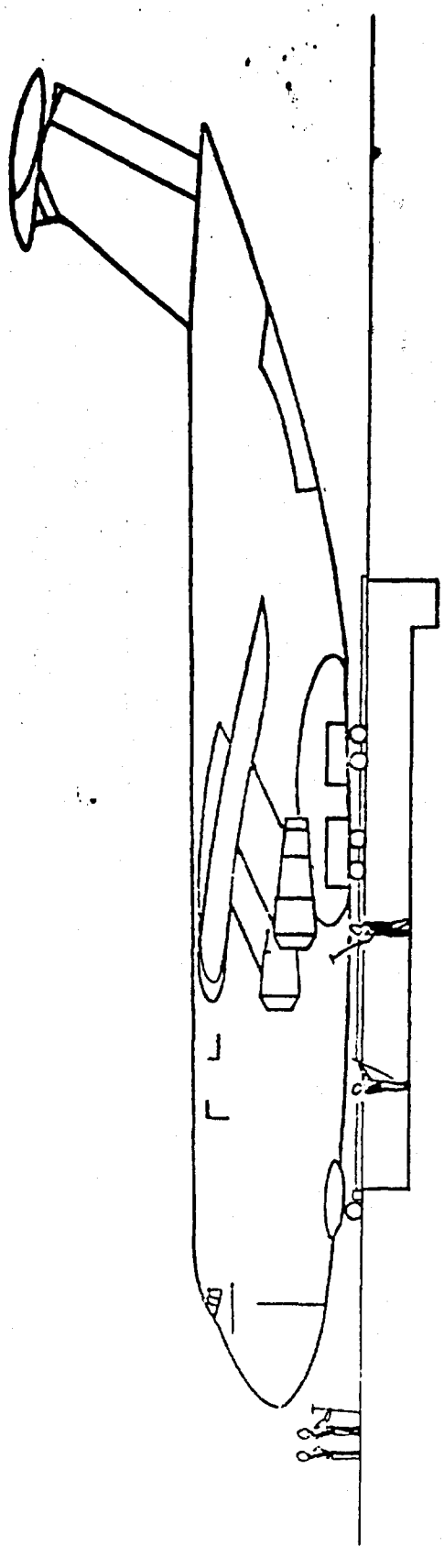


FIGURE 7. WORK TRENCH

a stripper barrel is nearly empty delivery becomes somewhat wasteful, because the flow is intermittent. The stripper comes out in surges and forms globs on the airplane and eventually falls to the ground. It is possible to eliminate this problem by only using the barrels down to a certain level and then collecting the remaining stripper in a single barrel. However, it is questionable whether getting that last gallon or two of stripper is worth that much effort. An alternative approach would be to pour the stripper into a central supply tank. Supply lines could be run from the central tank to individual work stations. Stripper temperature could also be easily controlled in a central supply tank, thereby eliminating the occasional problem of slow working cold stripper that is brought into the stripping area from outside storage on cool days. More than one storage tank would probably be required in order to provide the versatility of being able to turn a valve and select one stripper from several that might be used regularly.

There were a substantial number of lost man-hours observed during the day and swing shifts while workers were waiting on the stripper to work. On the day shift there was also some interference between workers because floor workers had to move away when the upper fuselage workers were applying stripper and sometimes when they were spraying water. On the swing shift only three people were used to apply stripper. The rest of the crew waited for about 20 minutes while stripper was being applied and then the entire crew waited for about 40 minutes for the stripper to work. During periods when the stripper is working a substantial amount of work could be done on other sections of the plane.

Some of the plane's surface was observed to be wet when the second coat of stripper was applied. The practice of applying stripper on a wet surface may tend to reduce the effectiveness of the second coat of stripper somewhat because water neutralizes the stripper. Technical Order 1-1-8 and most manufacturer's specifications for "non-phenol strippers for removing urethanes" also prohibit application to wet surfaces. People at other stripping facilities had differing opinions regarding the effect a damp surface has on a stripper's working efficiency.

During the swing shift operation the lighting under the wing appeared to be inadequate. Floor-level lighting would provide better visibility when stripping the lower surfaces of the plane.

The fixed scaffolding under the wings appeared to be adequate. It provided full access to the entire wing's lower surface as well as to

the engine pads. The only worker inconvenience noticed was that workers have to push around small stands to reach some areas under the wing.

The foreman reported that 16 barrels of phenol stripper were used on the plane observed being stripped and that 30 barrels is the norm when using non-phenol stripper. It appears that if a phenol stripper is permitted for normal use, the material requirements might be cut in half.

Aircraft Paint Removal at Tinker Air Force Base

The removal of paint from aircraft at Tinker Air Force Base is similar to that at Robins AFB. Both nonphenolic and phenolic-type strippers are used as approved under T.O. 1-1-8. A notable difference is the absence of personnel carriers suspended from the ceiling or other substantial access staging. Tinker personnel work from portable rollaway work stands. The chemical stripper is sprayed on the aircraft surface and allowed to remain for 30-45 minutes before it is brushed with wire brushes (reportedly, aluminum) and squeegeed off. A second coat of stripper is then applied and, after working for about 1-2 hours, is again agitated with wire brushes, aluminum wool, and squeegeed off. A third coat of stripper (solvent type) is then applied to the plane and after about 2 hours is hosed off. Spot stripping is then done as required to get all the paint off the plane. Used stripper and loosened paint is flushed down the sewer to the waste treatment plant.

The plane is sent through the reconditioning shops before being given a final detergent wash. A water break test is used to check surface cleanliness before repainting with MIL-P-23377 epoxy primer and MIL-C-83286 polyurethane topcoat.

Observation of Aircraft Paint Stripping at Tinker Air Force Base

A KC-135 aircraft was observed being partially stripped at Tinker Air Force Base (see Figure 8). The following are the approximate areas of the plane that were being stripped:

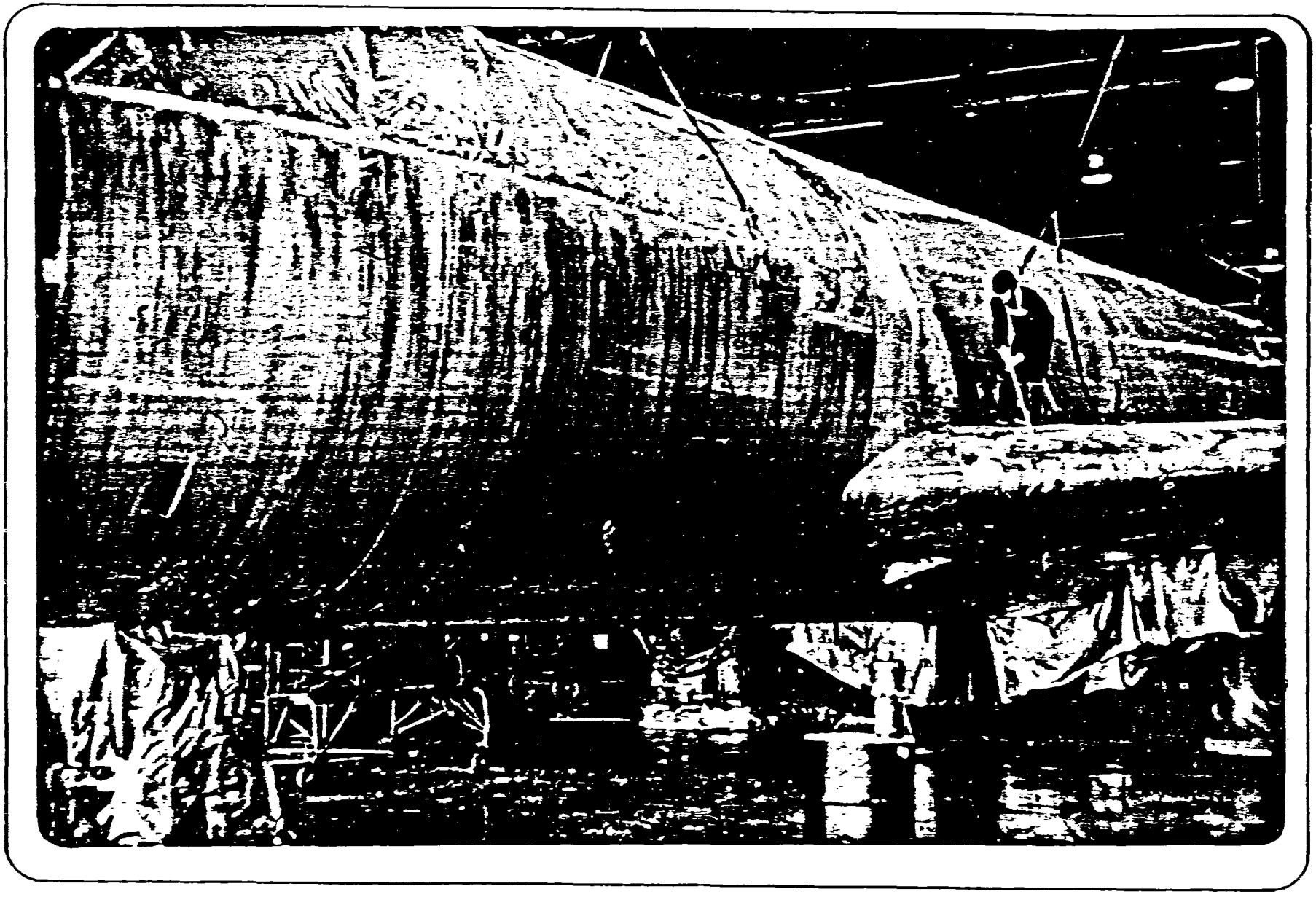


FIGURE 8. STRIPPING PAINT FROM A KC135 AT TINKER AFB

(1) The bottom half of the fuselage

(2) The top of the wings near the leading edge

(3) The bottom surface of the wings.

All other areas of the plane were masked with polyethylene sheet or other protective material. The areas that were not being stripped were to be lightly sanded before the plane was repainted.

Stripping Procedure

The plane was brought into the hanger and was partially masked during the graveyard shift. Some masking also continued during the day shift.

Eldorado P3500 was the first two coats of stripper applied to the plane. The stripper was described by the general foreman as being a hot (Phenol) stripper. For the third coat, a Western Omega Co. solvent-type stripper was used which was described as being a milder material.

The stripping procedure was as follows:

(1) Eldorado P3500 stripper was applied using barrel pumps and spray wands.

(2) The stripper was allowed to work for about 30 minutes before any agitation was done.

(3) The stripper was then aggressively brushed with small wire brushes (reportedly aluminum) approximately 1-1/2 inches square.

(4) After the surface had been wire brushed a rubber squeegee was used to remove as much of the stripper and loosened paint as possible. A water spray was not used. The general foreman stated that water was not used because a Corrogard paint was on the plane. He said that the Corrogard paint will harden up immediately if water is applied and any work that the stripper has done is destroyed. He added that stripper on polyurethane paint can be water sprayed with no ill effects but the Corrogard should definitely not be sprayed with water.

(5) A second coat of the Eldorado P3500 stripper was then applied and left on the plane about 2 hours.

(6) The second coat was aggressively agitated using aluminum wool. Aluminum wool or scotchbrite pads are not used on the first coat of stripper because they load up with paint debris.

(7) The stripper and loosened paint is then squeegeed from the plane so most of the paint left on the plane is primer.

(8) The plane surface is then sprayed with cold water and allowed to dry.

(9) A mild Western Omega Co. solvent-type stripper is then applied to the plane. This stripper was much less viscous than the Eldorado stripper and was translucent in appearance. The Omega stripper is used because it reportedly removes the primer better and cleans off the plane more readily than the Eldorado stripper.

(10) Removal of the Omega stripper was not observed. The foreman stated that, in general, over 95 percent of the plane's surface rinses clean to bare metal. Additional coats of stripper are applied to localized tough spots until the plane is 100 percent bare metal in the areas being stripped.

Observations

Eight people were assigned to the stripping operation that was observed. The men generally worked in pairs when that appeared to contribute to getting the job done. The men worked in assigned areas on the aircraft but moved to do another task on another area of the plane if the applied stripper was working on their assigned areas. There appeared to be minimal slack time and everyone kept relatively busy. Each worker was essentially working two areas of the plane at the same time. While the applied stripper was working on one location the worker would be scrubbing or brushing paint previously loosened by the stripper at another location.

No permanent staging was used. Roll-around portable jackup stands were used to provide access to the sides and upper surfaces of

the plane. Workers repeatedly had problems rolling the stands around because of interference with hoses on the floor. Overhead life lines were attached to the workers as shown in Figure 8 to prevent their slipping and falling from the wings to the floor. Wire brushes, aluminum wool, and squeegees were attached to handles approximately 5 feet in length. Barrel pumps and spray wands similar to those at Warner Robins were used to apply stripper to the aircraft. The wands did not have on/off valves which appeared to be an inconvenience in that a second man had to control the flow at the barrel pump.

The third coat of stripper was a solvent-type instead of the methylene chloride with phenol that was used for the first two coats. The reasons given were improved primer removal and better masking.

Stripper was not applied to the entire fuselage or on an entire wing in a single application. The reason for this was probably to avoid getting too much stripper on the plane so that it would dry before it could be removed. The brushing action took a substantial amount of time, and with stripper applied to the entire plane it might not have been possible to brush and remove it fast enough to prevent drying.

The spent stripper and paint are flushed down the drain and to the base sewage treatment plant. The plant is capable of handling a limited number of barrels of phenol stripper per day.

Main Differences Between Tinker and Robins Paint Stripping Operations

1. Much more agitation and brushing is done at Tinker.
2. Staging is more extensive and access to the plane is better at Robins AFB.
3. Masking at Tinker is much more extensive because only part of the plane is stripped.
4. Workers at Tinker are more spread out over the plane. Minimal interference between workers was observed.
5. No water is used on the plane at Tinker until after the second coat of stripper is squeegeed off. Robins washed off the first coat of stripper during the stripping operation observed there.

6. A phenol stripper, followed by a solvent-type stripper was used at Tinker. A phenol stripper was used 100 percent during the stripping operation observed at Robins AFB.

Information Gathering by Visits and Telephone Conversations

Information was gathered on the current state of the art in aircraft paint removal by telephone conversations and personal visits to paint stripping facilities. The following is a list of contacts that were made during the project.

Air bases contacted:

- Robins Air Force Base, Georgia
- McClellan Air Force Base, California
- Tinker Air Force Base, Oklahoma
- Alameda Naval Air Station, California
- North Island Naval Air Station, California
- Naval Air Station, Jacksonville, Florida
- Kelley Air Force Base, San Antonio, Texas.

Commercial airlines contacted:

- Continental Airlines, Los Angeles, California
  Flying Tiger Airlines, Los Angeles, California
  Frontier Airlines, Denver, Colorado
- United Airlines, San Francisco, California
- Braniff International Airlines, Dallas, Texas
- Trans World Airlines, Kansas City, Missouri
  North Central Airlines, Minneapolis, Minnesota
- National Airlines, Miami, Florida
- Eastern Airlines, Miami, Florida
- Delta Airlines, Atlanta Georgia
- Western Airlines, Los Angeles, California
  World Airways Inc., Oakland, California
  Pan American Airlines, New York, New York.

Aircraft manufacturers contacted:

- Boeing Aircraft Corporation, Everett, Washington
- Lockheed California Company, Burbank, California
- Lockheed Georgia, Marietta, Georgia
  McDonnell Douglas Aircraft Corp. St. Louis, Missouri

Commercial aircraft strippers contacted:

- o Aero Corp., Lake City, Florida
- o Hayes International, Birmingham, Alabama
- o Unified Aircraft Service, Rialto, California.

Suppliers of chemical strippers contacted:

Leeder Chemical Inc., Paramount, California
Intex Products, Inc., Greenville, S. Carolina
McGean Chemical (Cee Bee Strippers), California

- o B and B Chemicals, Miami, Florida

Eldorado Chemical Inc., San Antonia, Texas
Inland Chemical Company, Orange, California
Penwalt Chemical Corp., Philadelphia, Pennsylvania.

A written summary of the information obtained from each of the contacts is in the Appendices (A-E) of this report.

The information obtained from visits and telephone conversations has been summarized to show the comparisons of aircraft depainting by air bases, commercial airlines, contract strippers, and aircraft manufacturers in Table 1.

Comparison of Stripping Methods and Facilities

Preparation for Stripping.

Washing. Some of the stripping facilities washed their planes prior to stripping but most did not. The general feeling was that a dirt or grease film has a negligible effect on the strippers ability to remove paint and that washing is just another step that adds cost. Most people indicated, however, that it is best to clean extremely greasy or dirty areas.

Masking. All facilities masked vulnerable areas of the aircraft prior to applying stripper. The masking techniques were generally similar. Masking materials included heavy-duty aluminum paper, polyethylene

---

o Indicates personal visit - others are telephone contacts.

TABLE 1. AIRCRAFT DEPAINTING SUMMARY

Organization	Aircraft Stripped	Area of Plane Stripped	Paint System	Stripping Mat'l	Quantity of Stripping Mat'l Used	Approximate Man-Hours Req'd to Strip Plane	Unique Features of Operation
Air Bases							
• Alamada Naval Air Station, Alamada, CA	A-4, A-6, A-7, P-3, S-3, C-118, C-130, etc.	Partial to 100%	Polyurethane topcoat Epoxy primer	Mil-R-81294 Mil-R-81903	--	--	None
• Jacksonville Naval Air Station Jacksonville, FL	A-7, P-3, NASC, S-2	Most are 100%	Polyurethane Epoxy Primer	Mil-R-81294	--	400 MH for P-3	1. Central stripper storage tanks. 2. Masking, stripping, blasting & anodizing all in separate hangers. 3. Power ladders.
• Kelley Air Force Base San Antonio, TX	C-5	Spot stripping at present anticipated going to 100% strip	Polyurethane topcoat Polysulfide primer	Phenol stripper will be used when 100% stripping is done	Estimate 1200 gal for 100% strip of C5	Estimate 6000 MH for 100% strip of C5	1. Use MEK prior to masking. 2. Water jet removal of stripper (squeegee not used).
• McClellan AFB Sacramento, CA	F-106, F-105 Helicopters			Turco 5873 Turco 5351 Eldorado PR3400	200 gal	156 hours	None
• North Island Naval Air Station San Diego, CA	E-2, F-4, C-2, H-46 Helicopter		Polyurethane topcoat Epoxy primer	Mil-R-81294 Mil-R-81903	8 bbl for E2	320-500 MH for E2	1. Stripper in central storage tanks. 2. Use steam entrained hot water to remove stripper.
• Tinker Air Force Base Oklahoma City, OK	KC135	Lower fuselage under wing. Lead edge of wing.	Polyurethane topcoat 3M Corrogard primer	Eldorado P3500 Western Omega Co. solvent stripper	15 bbl	500-600 MH Estimate	1. Agitation is very aggressive
• Warner Robbins AFB Warner Robbins, CA	C-141	100%	Polyurethane topcoat Epoxy primer	Mil-R-25134	16 bbl phenol (30 bbl if non-phenol is used)	700-900 MH	1. Overhead cages 2. Moveable deck for tail access 3. Under wing permanent staging.
Commercial Airlines							
• Braniff Int'l Airlines Dallas, TX	727, DC-8	100%	Polyurethane topcoat Wash primer	Eldorado P3400 Turco 5351 Eldorado AP-80 solvent and Intex 8243 solvent	4-6 bbl	500-800 MH	1. Use powered corrosion wheel(scotchbrite pad) 2. Planes are not alodized.

• Indicates personal visit to facility. Others are telephone contacts only.

TABLE 1. (Continued)

Organization	Aircraft Stripped	Area of Plane Stripped	Paint System	Stripping Mat'l	Quantity of Stripping Mat'l Used	Approximate Man-Hours Req'd to Strip Plane	Unique Features of Operation
Commercial Airlines (continued)							
• Continental Airlines Los Angeles, CA	727	Upper Fuselage	Polyurethane or Teflon	Inland 508 Inland 561		288-304 MH	1. Stripping done outside
• Delta Airlines Atlanta, GA	DC-8, DC-9, L1011, 727	Upper Fuselage	Polyurethane over wash primer or epoxy primer	Intex 8573 Turco 5351	4-6 bbl for Wash primer 10-12 bbl for epoxy primer	125-165 MH for wash primered plane 385-575 MH for epoxy primered paint	1. Extensive tail staging. 2. Overhead X,Y,Z carriage for workers. 3. Plane is double masked (aluminum tape over polyethylene).
• Eastern Airlines Miami, FL	727, DC9, L1011	Upper Fuselage		Methylene Chloride with Phenol (make unknown)	4-6 bbl for DC-9 6-7 bbl for 727		None
Flying Tiger Los Angeles, CA	DC-8	Decorative strips on side		Turco B19 Cee Bee A292 Cee Bee A202		96 MH for removal of decorative stripe and tail paint	None
Frontier Airlines Denver, CO	737, etc.	Upper Fuselage		B&B/1717		100-120 MH	None
• National Airlines Miami, FL	727,DC10	Upper Fuselage	Polyurethane topcoat over wash primer	Cee Bee A29SCW	4-5 bbl for 727		1. Most stripping done outside. 2. Stacker cranes available for indoor stripping.
North Central Airlines Minneapolis, MN	DC9, Convair 550	Upper Fuselage	Polyurethane over wash primer	Cee Bee 292 Cee Bee 350 cleaner for final cleaning		216 MH	None
Pan American Airlines New York, NY	707, 727, 747, 747S		Polyurethane over wash primer	(Stripping Facilities in process of being moved from Miami to New York so detailed information was not available)			
• Trans World Airlines Kansas City, MO	707, 727, 747, L1011, DC9	Upper Fuselage	Polyurethane over wash primer	Cee Bee A29SCW	3-4 bbl for 727	96 MH for 727	1. Four Floor supported track mounted vehicles with work platforms on booms used to provide worker access to plane.

• Indicates personal visit to facility. Others are telephone contacts only.

TABLE 1. (Continued)

Organization	Aircraft Stripped	Area of Plane Stripped	Paint System	Stripping Mat'l	Quantity of Stripping Mat'l Used	Approximate Man-Hours Req'd to Strip Plane	Unique Features of Operation
Commercial Airlines (continued)							
• United Airlines San Francisco, CA	727, 737, 747, DC8, DC10	Upper Fuselage	Polyurethane topcoat Primer unknown	Inland & Leeder (Try non-Phenol and then use Phenol as req'd) Cee Bee A918 cleaner with scotchbrite pad for final clean.	6-8 bbl for smaller aircraft 18 bbl for wide body	225 for smaller aircraft Up to 675 for wide body	1. Other maintenance done while stripping 2. Investigating reuse of stripper. 3. Stripping personnel also do painting
• Western Airlines Los Angeles, CA	707,720,727, 737	Fuselage		Leeder Acid Stripper	4 - 7-1/2 bbl	48-90 MH	None
World Airlines Oakland, CA	Most stripping work is contracted to Unified Aircraft Services.						
Contract Stripper Operators							
• Aerocorp Lake	C-130	100%		Intex 8562	21 bbl	500 MH normally 1200 MH max. for unusual cases	
• Hayes Int'l Birmingham, AL	C-130 KC135,WC135	30 - 100%		B&B 1776 B&B 1567A		240-320 MH	1. Central stripper storage
• Unified Aircraft Services Rialto, CA	707,727, 747, TC8, KC141, DC9, etc.	Variable	Variable	Inland AP561A	1.5 bbl (for commercial plane)	200 MH (for commercial plane)	1. Will usually take 8 men to stripping location & work straight through until job is complete
Aircraft Companies							
• Boeing Aircraft Everett, WA	747	Fuselage	Polyurethane over Epoxy Primer	Turco 5351 50-50 mix of MEK & Toluene for corroguard on wings		208 MH	1. Painter personal do stripping. 2. Use stacker cranes. 3. Stripper carried on stacker crane.
• Lockheed California Co. Burbank, CA				Investigating dry ice blasting on laboratory scale.	Expected to be very high		
• Lockheed Georgia Co. Marietta, GA	Few planes have been stripped at Lockheed Georgia		Polyurethane over wash primer (A switch to epoxy primer is being made)	Mil-R-25134 (Turco 1D,1E)	Not Available	Not available	None
McDonnell Douglas St.Louis, MO	Mainly small parts only are stripped						

• Indicate personal visit to facility. Others are telephone contacts only.

sheet, aluminum backed tape, and plastic tape. Several operations used a double masking technique which involved the use of aluminum tape over plastic tape. The reason for double masking is to reduce the possibility of the tape being lifted during the stripping and washing operations. It was reported that water tends to lift the aluminum tape and stripper tends to release plastic tape. Several people indicated that masking is the most important step in the stripping operation. Generally these people were involved with stripping commercial airplanes on which extensive masking is required.

Precut aluminum barrier paper was used during the masking process at several stripping facilities. It was reported that use of the precut panels reduces masking time especially around windows.

Stripping Material. All of the aircraft depainting facilities contacted used a chemical stripper approach to the paint removal task. All operations used methylene chloride based materials as their principle stripping agent but some were more willing to use the stronger materials containing phenol or phenol and organic acid (such as hydroxyacetic).

The use of acid strippers (methylene chloride-phenol-organic acid) is acceptable to some airline companies, and they are commonly used by at least one of the companies that strips paint on a contract basis. The acid strippers can cause stress corrosion cracking of high-strength steels so are not used by the Air Force. Present masking procedures are not "fool proof" enough to assure that no stripper will come into contact with the high-strength steels of military aircraft. Protection of the landing gear on commercial aircraft is probably easier because the underside of the fuselage is generally not painted.

Some facilities used the same stripper for the complete "start-to finish" stripping operation while others secondary stripping materials that differed from the primary stripper. Secondary materials included MEK, solvent-type strippers and various commercial formulated cleaning materials. The reasons given for using of the secondary materials were that they removed the primer better or that they were easier to remove (usually by washing) than the primary stripper being used. At Delta, B-B-1000, (a commercial solvent) is used to wipe down the plane after stripping to reduce the volume of waste and potential runoff. Water is not used to

rinse the plane until the plane has been wiped down with solvent and the spent stripper completely cleaned off the floor. This procedure is followed to prevent any of the stripper from entering the sewer.

Stripper Application. Stripper material is applied by two methods which include spraying it on with an airless sprayer and flowing it on followed by distribution with brushes. The predominant method used is application by airless sprayer. The flowing on and brush distribution method is used by United. The reason for their using that method is probably to eliminate stripper being entrained in the atmosphere which sometimes occurs during the spray application method. United has many other workers around the plane during the stripping operation and flowing on the stripper and distributing it by brushing is a more controllable application method.

At most facilities stripper was pumped directly from 55-gallon drums using barrel pumps. However several facilities used bulk storage tanks for storing stripper. Pumping from the 55-gallon drums offers somewhat more versatility in that one can switch easily from one stripper to another by simply moving the barrel pump to another barrel. Frequent changing from one stripper to another with bulk storage would require several tanks. Bulk storage makes temperature control of the stripper easier. Cold stripper reportedly works slower on paint than stripper that is at room temperature. Bulk storage also eliminates some of the barrel handling problems and clutter around the stripping area.

Stripper Agitation. At all facilities contacted the stripper is allowed to work on the paint for some length of time and is then agitated and removed. The extent of agitation varied from none to very aggressive agitation. Most places brushed the stripper and loosened paint around with mops or polypropylene brushes. Tinker Air Force Base agitated their stripper very aggressively by using small wire brushes (reported to be aluminum) and aluminum wool. The general philosophy was to let the stripper do the work if at all possible. Many places simply use a stronger stripper when tough spots are encountered instead of resorting to more aggressive brushing techniques.

Agitation at all facilities is done by hand (i.e., brushes were mounted on long handles and worked by hand) except for the final stages of

paint removal at Braniff. They use a hand-held rotary power disc with a circular Scotchbrite pad for final paint removal. The same device is used for feathering edges of paint spots that will not come off the plane. Braniff personnel stated that this power tool had to be used with great care to prevent damaging the substrate.

A large number of places use scotchbrite pads to aid in the final cleanup of the plane. These pads are often used in conjunction with a solvent or commercial cleaner. Aluminum wool is also used at a number of facilities as an aid to removing loosened paint.

Stripper Removal. Stripper is removed with squeegees or by water spray. The water temperature ranges from cold to hot. Some facilities use only squeegees because they don't want to wet the plane. Personnel at those facilities claim that the subsequent coat of stripper won't work well on a damp surface and they don't want to wait for the plane's skin to dry. People at other facilities claim their stripper is not affected by a damp surface and, therefore, apply stripper over a recently rinsed plane without waiting for it to dry.

Several operators indicated cold water is used at their facility because of fumes that are generated when hot water or steam is used to remove stripper. No one that used hot water gave good reasons why hot water should be expected to work better than cold for removing stripper and paint residue.

San Antonio uses 200 psi water a so-called "beam gun" to remove stripper and loosened paint. They stated their belief that the water jet aids in undercutting loosened paint and blasts it off the plane surface.

Waste Disposal. The used stripper disposal methods that were encountered are as follows:

(1) Collect the sludge in barrels or a bulk tank and ultimately dispose of it in a sanitary landfill.

(2) Drain the spent stripper and wash water to a waste treatment plant before discharging into a stream.

(3) Give used stripper to a reclamation company.

Sanitary landfill disposal (method 1) was most frequently encountered at commercial airlines especially those located on the West Coast. The waste material is either picked up and put into barrels or is collected in a sump for subsequent transfer to a bulk tanker truck. There is serious concern about possible future EPA regulations that could eliminate sanitary landfills as a disposal method.

The disposal method for running the used stripper and wash water through a waste treatment plant and ultimately into a stream was encountered most frequently at military bases. Although several commercial airlines had sewage treatment plants at their overhaul bases, they still elected to not run their paint stripping waste through the plants because of the treatment cost or because their plants were not capable of handling the waste.

Boeing Aircraft Company disposes of their waste through a reclamation company in order to reduce disposal costs somewhat. However, they still pay 15 to 20 cents per gallon for disposal.

Disposal through a reclamation company is appealing because it may be possible to get some reduction in disposal cost if the stripper waste can be considered to have some reclamation value. However, it may be difficult to locate a reclamation firm that can handle the used stripper. If a reclamation firm can be located it is advisable that a secondary disposal method be arranged for.

Staging and Airplane Access Equipment. The staging equipment for providing the workers access to a plane's surfaces varied widely at the stripping facilities visited. The following are some of the types of staging being used:

(1) Cherry picker vehicles with personnel baskets on the boom.

(2) Roll-around scaffolding that is raised and lowered with power or by hand.

(3) Permanently installed staging with either fixed deck or movable deck levels.

(4) Extensive scaffolding or work platforms that are moved in adjacent to a plane and left for the duration of the stripping process.

(5) Wheeled vehicles supported on tracks with boom-mounted personnel baskets that move along the wings and fuselage of the plane.

(6) Overhead work decks that have three degree of freedom (x, y, z) movement capability.

Cherry pickers are used by stripping operators generally when high versatilibv is required and stripping facilities are limited. A personnel basket mounted on a cherry picker boom can reach all the surfaces of a plane. However, the risk of damaging the plane with the boom is appreciable.

Scaffolding that is mobile and is moved by hand is used at several stripping facilities. These units provide a low-cost method of giving workers access to much of a plane's surface. However, there is a substantial inconvenience when a worker has to move the stand or scaffold from one point to another. Hoses laying on the floor at most stripping installations interfere with stand movement. If the stands are raised and lowered frequently during the stripping operations, a hydraulic hand pump is a time consuming method of adjusting stand height.

Permanently installed staging is used at Delta and United. Their staging is also used for maintenance tasks other than stripping. At Delta the permanent staging is around the tail section and the deck levels are movable. United's staging surrounds the plane and is movable so it can be rolled into place. The permanent staging provided excellent access to the plane's surface but the required structure is massive and expensive.

Delta utilizes overhead three degree of freedom platforms in addition to their permanent tail staging to provide worker access to the fuselage. The work platforms are supported on an extensive overhead structure. Boeing also had three degree of freedom overhead work platforms that utilized a stacker crane type unit for mobility. Boeing personnel expressed a preference for the overhead platform over permanent staging because the platforms provide worker mobility and they can reach almost all upper surfaces of the planes. The cable-supported platforms at Warner Robins ALC appeared to be just as efficient although perhaps not as steady as those seen at Boeing and Delta. The Warner Robins units are simpler than the Boeing or Delta units and they have less rigid structure that could damage the plane.

One commercial airline uses four track-guided vehicles (Figure 9) for providing worker access to a plane. Two vehicles are on tracks that are located along the leading edge of the wings and along the forward fuselage. The second two vehicles are mounted on tracks that run parallel to the fuselage aft of the wing. The vehicles are controlled from personnel baskets that are mounted on an articulated boom. Stripper and wash water lines are routed up the boom to the personnel basket.

Laboratory Comparison of Stripping Efficiencies of Selected Commercial Stripping Materials

Eleven commercial stripping materials have been comparatively rated for efficiency in removing paint from two different aircraft skins obtained from Warner Robins. The primary reason for this study was to check the relative efficiency of phenolic versus non-phenolic strippers. Some reports from the visits with persons stripping aircraft were positive in identifying phenolics as being more efficient than non-phenolic, while others were contradictory. In this laboratory work an effort was made to compare the efficiencies of the following: phenol, non-phenol, and two acid-type strippers.

BCL No.	Description	T.O. 1-1-8 Approval
1	Phenol, acid-type (no fluorides)	no
2	Phenol, acid-type	no
3	Acid, non-phenol	no
4	Phenol	yes
5	Phenol in methylene chloride (no ammonia)	no
6	Phenol	yes
7	Phenol, meutral (approved MIL-R-81294)	no
8	14% Phenol in methylene chloride	yes
9	Non-phenol, methylene chloride, low alchol	yes
11	Non-phenol	yes
11	Non-phenol, ammoniated	yes

Each of these eleven strippers was evaluated on two different substrates. One substrate was identified as a weathered section of a C130. The paint was relatively thin ($\sim$ 3 mils) and very difficult to remove. The source of the second substrate was not identified. However, this sample was a roll of aircraft skin which had been peeled from its reinforcing ribs. It appeared to have been hand painted. Film thickness varied greatly and the paint was considerably thicker than that on the first substrate.

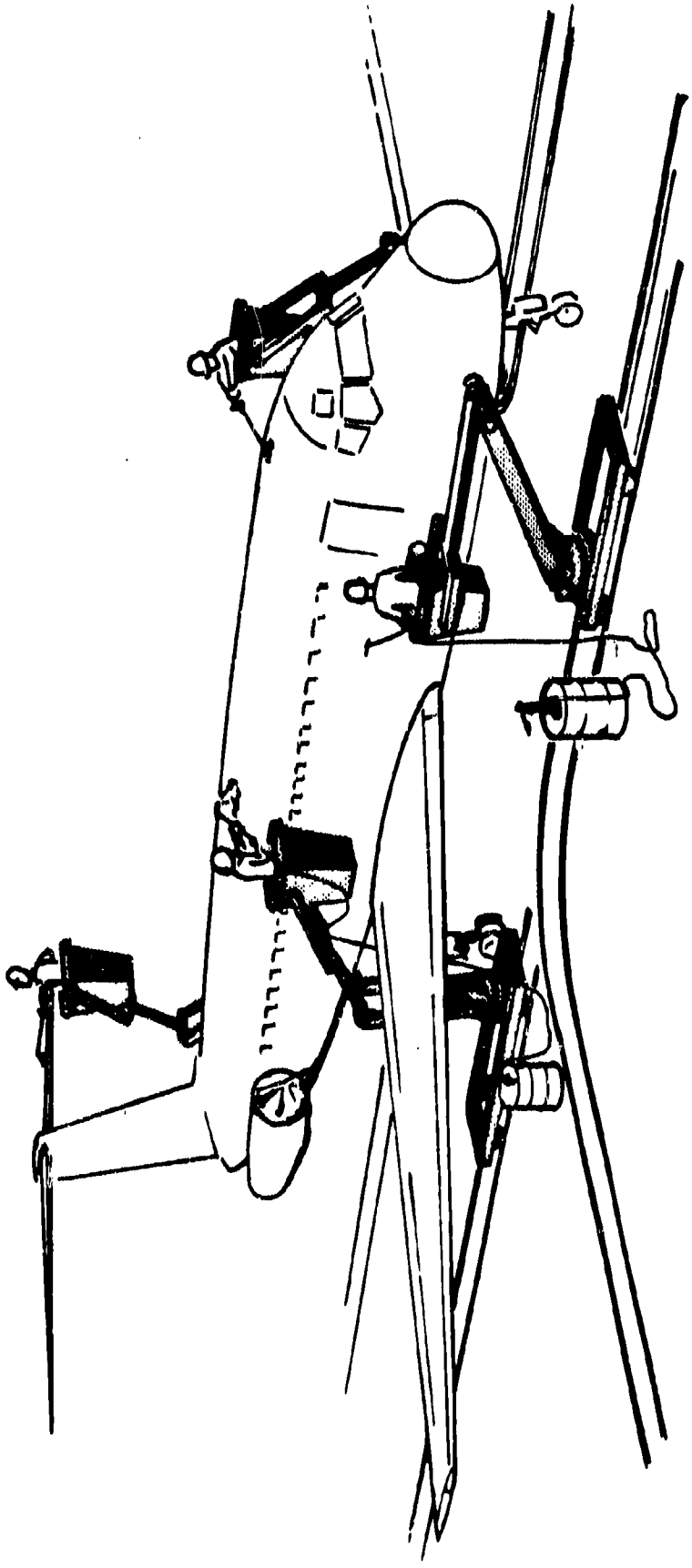


FIGURE 9. USE OF RAIL-GUIDED CHERRY PICKERS FOR OBTAINING ACCESS TO AIRCRAFT SURFACES

Each of the two substrates was cut into 4 x 6-test coupons to allow spot tests of all eleven strippers on each. The first test procedure consisted of placing 2- to 4-inch-diameter spots of each stripper on the ribbed test coupons (reported as C130). Stripping activity (lifting) was rated after 45 minutes. The specimens were then rinsed clean and rated a second time for "percent paint removal", and photographed. The spot test procedure for the second substrate (rolled skin) was different because of the heavy coating of paint. The spots (covered with strippers) were rated for activity after 10 minutes of exposure to the eleven strippers. Panels were rinsed, dried, and reexposed to the strippers. After 15 minutes (25 minutes total including the initial 10 minutes' exposure) the panels were again rinsed and rated for percent paint removal after the two applications. These two studies are summarized in Table 2. Photographs of each of the spot tests of the eleven stripping compounds after 45 minutes (Procedure No. 1) and after 25 minutes (Procedure No. 2) have been included in this report immediately following Table 2. These are Figures 10 through 20.

Two major conclusions can be drawn from this brief study. First, any specific stripping material may not perform equally well on different painted surfaces. An example of this is BCL No. 3 (acid-type, non-phenol) which was outstanding (100 percent paint removed) in one test and only "very good" (50 percent paint removed) in a second test.

A second major conclusion is that there are wide variations of perform ce within any major type of stripping material (acid, phenol, non-phenol) Therefore, it is not satisfactory to simply rate a material by generic type. For example, the two phenol, acid-type strippers (BCL Nos. 1 and 2) were rated as outstanding (100% paint removed) and extremely poor (0% paint removed), respectively, on a common substrate. In the second test using a different painted surface, both materials were rated consistently "excellent".

It is possible to generally consider stripper performance by type. The phenol (acid-type) and the acid (non-phenol) are the most effective materials. Damage to substrate must be assessed closely. The non-acid phenols are less effective than the above classes and their effectiveness decreases in proportion to the amount of phenol removed from the formulation.

TABLE 2. COMPARATIVE RATINGS OF VARIOUS COMMERCIAL PAINT STRIPPING MATERIALS[a] ON TWO DIFFERENT SUBSTRATES

BCL No.[b]	Description of Stripper	T.O. 1-1-8 Approval	Test Procedure No. 1		Test Procedure No. 2		
			Lifting[c] After 45 min (Before Rinsing)	Paint Removal (percent) After 45 min and Rinsing	Lifting[c] 1st Application (10 min)	Lifting[c] 2nd Application (15 min)	Percent Paint Removal After 2nd Application
1	Phenol, acid type, no fluorides	No	4	100	4	4	100
2	Phenol, acid type	No	4	100	0	0	0
3	Acid, non-phenol	No	4	100	3	3	50
4	Phenol	Yes	3+	90	1	1-2	80-90
5	Phenol in methylene chloride (no ammonia)	No	3	50	1	0-1	20-25
6	Phenol	Yes	2	25	1	2-3	40-50
7	Phenol, neutral (approved MIL-R-81294)	No	2	25	0	0-1	10
8	1-1 Phenol, in methylene chloride	Yes	1	10	0-1	1	40
9	Non-phenol, methylene chloride, low alcohol	Yes	1	10	3	1	15-20
10	Non-phenol	Yes	0	0	4	4	10-15
11	Non-phenol, ammoniated	Yes	0	0	2	2	2-4

(a) Spot tests of commercial stripping materials on samples of painted aircraft skin obtained from Warner Robins Air Force Base.

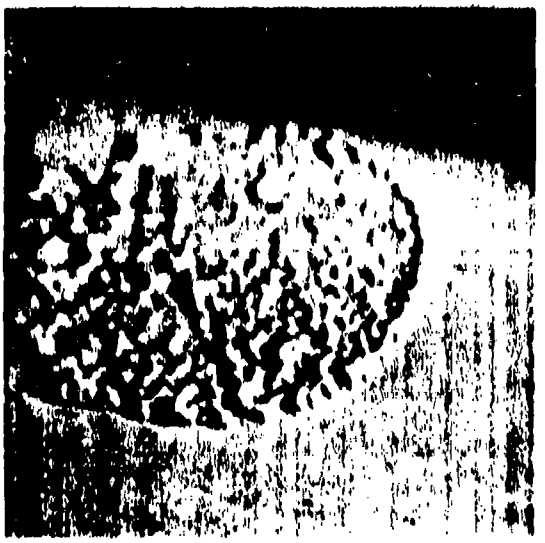
(b) All materials assigned BCL numbers to avoid commercial identification.

(c) Stripping activity observed as amount of "lifting" and rated 0-4 where 4 = heavy, 3 = moderate, 2 = slight, 1 = very slight, and 0 = none.

Figure 10.

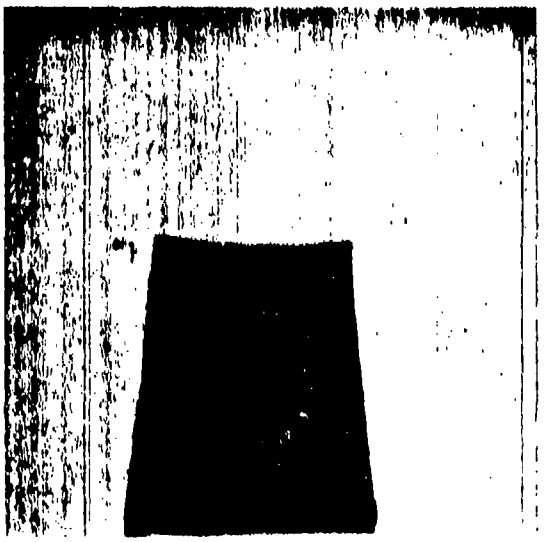
Commercial Paint Stripper No. 1

(Phenol, acid type, no fluorides)



Condition of Paint Surface
after 45 minutes

Test Procedure No. 1 on
Ribbed Aricraft Samples
From KC-131



Condition of Paint Surface
after 25 minutes

Test Procedure No. 2 on
Unidentified Aircraft Skin (10 min
exposure, rinse, 15 min exposure)

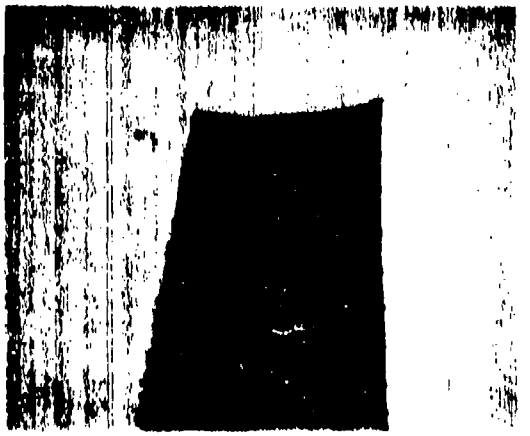
Figure 11.

Commercial Paint Stripper No. 2

(Phenol, acid type)

Condition of Paint Surface
after 45 minutes

Test Procedure No. 1 on
Ribbed Aricraft Samples
From KC-131



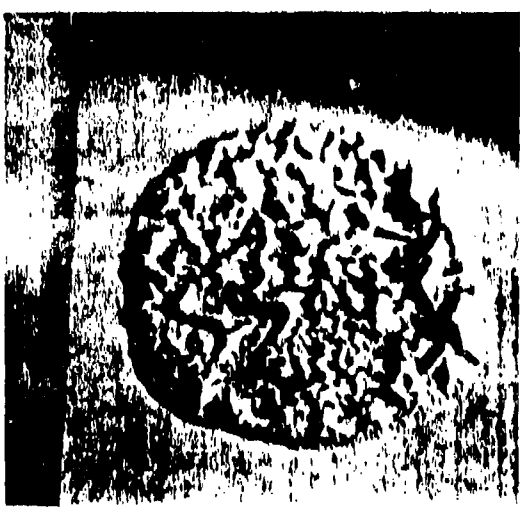
Condition of Paint Surface
after 25 minutes

Test Procedure No. 2 on
Unidentified Aircraft Skin (10 min
exposure, rinse, 15 min exposure)

Figure 12.

Commercial Paint Stripper No. 3

(Acid, non-phenol)



Condition of Paint Surface
after 45 minutes

Test Procedure No. 1 on
Ribbed Aricraft Samples
From KC-131

Condition of Paint Surface
after 25 minutes

Test Procedure No. 2 on
Unidentified Aircraft Skin (10 min
exposure, rinse, 15 min exposure)

Figure 13

Commercial Paint Stripper No. 4

(Phenol)

Condition of Paint Surface after 45 minutes

Test Procedure No. 1 on Ribbed Aircraft Samples From KC-131

Condition of Paint Surface after 25 minutes

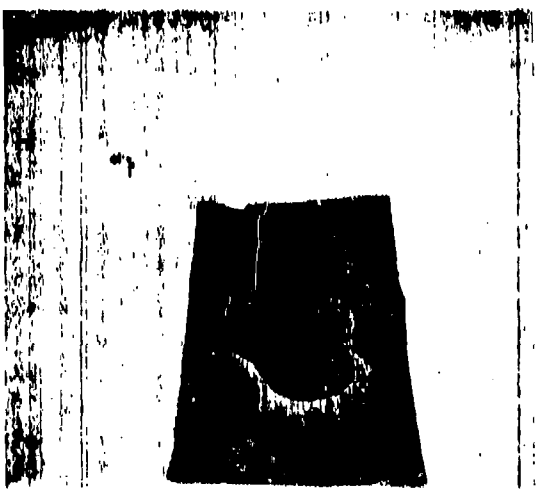
Test Procedure No. 2 on Unidentified Aircraft Skin (10 min exposure, rinse, 15 min exposure)

Figure 14.

Commercial Paint Stripper No. 5
(Phenol in Methylene Chloride)

Condition of Paint Surface
after 45 minutes

Test Procedure No. 1 on
Ribbed Aricraft Samples
From KC-131



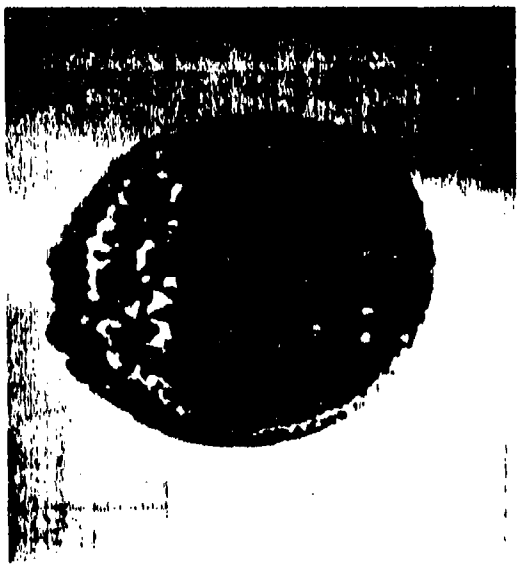
Condition of Paint Surface
after 25 minutes

Test Procedure No. 2 on
Unidentified Aircraft Skin (10 min
exposure, rinse, 15 min exposure)

Figure 15

Commercial Paint Stripper No. 6

(Phenol)



Condition of Paint Surface
after 45 minutes

Test Procedure No. 1 on
Ribbed Aricraft Samples
From KC-131

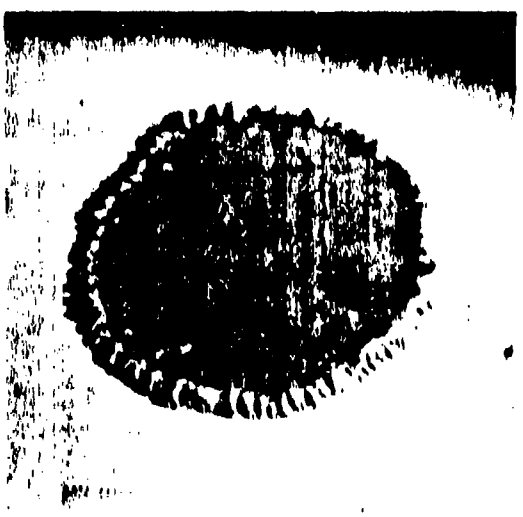
Condition of Paint Surface
after 25 minutes

Test Procedure No. 2 on
Unidentified Aircraft Skin (10 min
exposure, rinse, 15 min exposure)

Figure 16

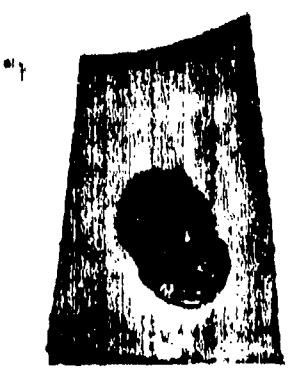
Commercial Paint Stripper No. 7

(Phenol, neutral)



Condition of Paint Surface
after 45 minutes

Test Procedure No. 1 on
Ribbed Aricraft Samples
From KC-131



Condition of Paint Surface
after 25 minutes

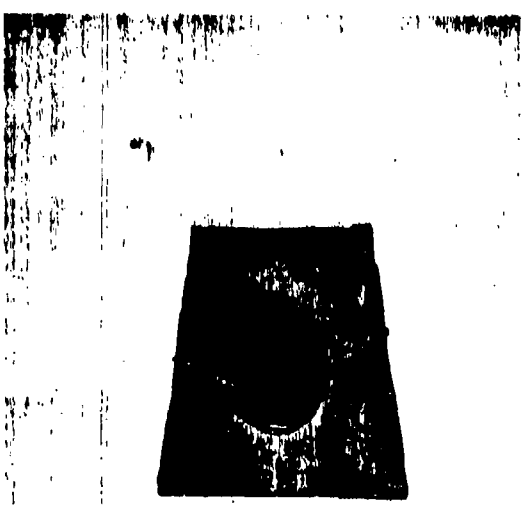
Test Procedure No. 2 on
Unidentified Aircraft Skin (10 min
exposure, rinse, 15 min exposure)

Figure 17

Commercial Paint Stripper No. 8
(14% phenol in methylene chloride)

Condition of Paint Surface
after 45 minutes

Test Procedure No. 1 on
Ribbed Aricraft Samples
From KC-131



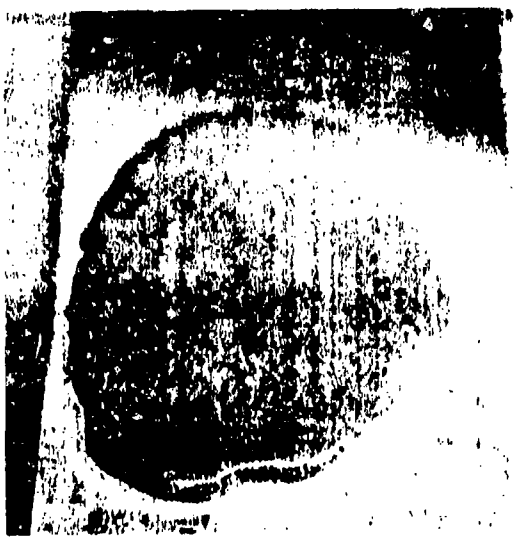
Condition of Paint Surface
after 25 minutes

Test Procedure No. 2 on
Unidentified Aircraft Skin (10 min
exposure, rinse, 15 min exposure)

Figure 18

Commercial Paint Stripper No. 9

(Non-phenol, methylene chloride, low alcohol)



Condition of Paint Surface after 43 minutes

Test Procedure No. 1 on Ribbed Aricraft Samples From KC-131

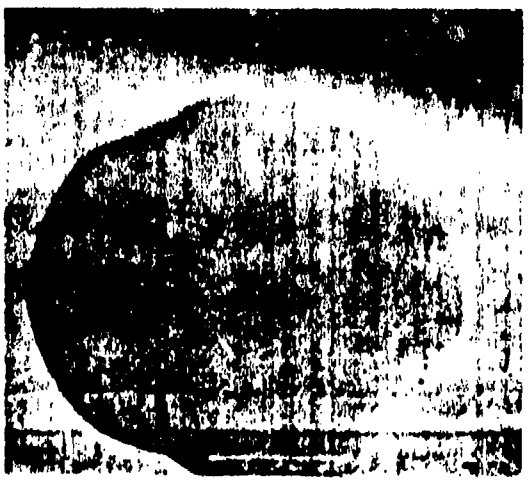
Condition of Paint Surface after 25 minutes

Test Procedure No. 2 on Unidentified Aircraft Skin (10 min exposure, rinse, 15 min exposure)

Figure 19

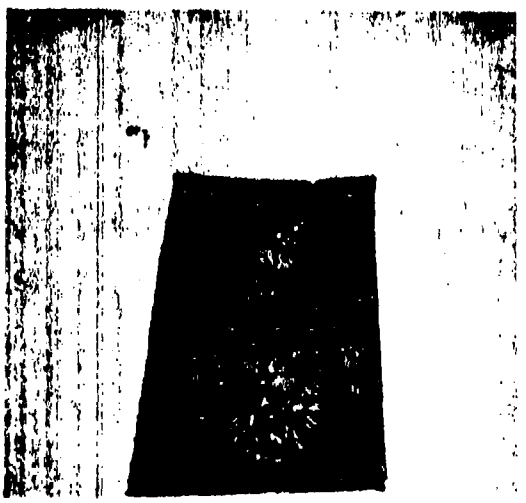
Commercial Paint Stripper No. 10

(Non-phenol)



Condition of Paint Surface
after 45 minutes

Test Procedure No. 1 on
Ribbed Aricraft Samples
From KC-131



Condition of Paint Surface
after 25 minutes

Test Procedure No. 2 on
Unidentified Aircraft Skin (10 min
exposure, rinse, 15 min exposure)

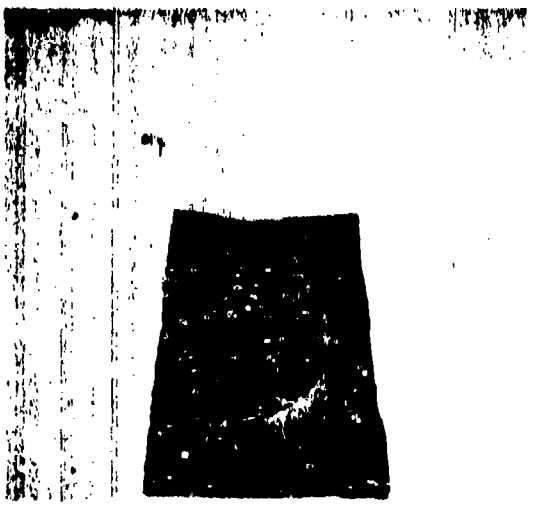
Figure 20

Commercial Paint Stripper No. 11

(Non-phenol, ammoniated)

Condition of Paint Surface after 45 minutes

Test Procedure No. 1 on Ribbed Aricraft Samples From KC-131



Condition of Paint Surface after 25 minutes

Test Procedure No. 2 on Unidentified Aircraft Skin (10 min exposure, rinse, 15 min exposure)

The non-phenols are the least effective of the types studied. Since there s some variation in performance among these materials (BCL Nos. 9, 10, 11), and since these are the types commonly approved for stripping military aircraft, it is of paramount importance to examine each one on a performance basis for each specific paint removal need and not simply by generic type.

Alternative Non-Chemical Methods of Stripping Paint From Aircraft

During the course of this program several non-chemical methods of stripping paint were discussed with people at the various airplane depainting facilities. In addition, two other methods were investigated briefly at Battelle. These non-chemical or mechanical paint stripping methods are as follows:

1. Blasting with dry ice, walnut shells, etc.
2. Water jet blasting
3. Ultrasonics
4. Elevated temperature.

Mechanical stripping is appealing because the chemical stripper, which poses a serious waste disposal problem, is eliminated. However, none of the methods of non-chemical paint stripping appear to be a viable alternative to chemical stripping at present. All are in the idea or in the laboratory stages and have not been satisfactorily demonstrated to be feasible from an operational or cost standpoint. Mechanical methods in general are predicted to be labor intensive because they are applied to small areas and are not applicable to a large overall area as is the case with a chemical stripper.

Abrasive Blasting. The Lockheed California Company has done some experimental work with dry ice blasting as a paint removal method. Dry ice blasting is appealing because the CO_2 pellets will evaporate after being used and only dry paint chips remain as the end waste product. No clean up of the blasting material would be required as is the case with walnut shells, sand, etc. Lockheed personnel project a cost increase of up to 100 times over that of chemical stripping. There

is sufficient laboratory data to accurately predict a final cost but brief experiments run at Battelle confirm that the process would be extremely slow and costly. The amount of compressed air and dry ice, both of which are expensive, that would be required to strip a plane is very great. Lockheed is not placing much emphasis on dry ice blasting and their present funding of research efforts is very low. Lockheed personnel stated that dry ice blasting is probably only applicable to special cases such as cleaning blades in an assembled engine.

Blasting with dry ice or other dry abrasive particles all share several disadvantages. First, the process is slow because it is impractical to have a blasting nozzle that will cover more than a few square inches at a time. Secondly, a fairly "non-agressive" blasting material such as walnut shells or dry ice must be used to reduce the possibility of damaging the aluminum skin. Even with these so-called non-agressive materials experience has shown that the skin can be damaged very easily because the force due to the impinging particles can deform the skin causing depressions between support structures. The third and perhaps most important disadvantage is that any blasting process would most probably be very expensive as compared to chemical stripping because of the time and manpower required.

Water Jet Blasting. Personnel at Boeing indicated that they are planning to investigate water jet blasting as a paint stripping method. They are only in the idea stage at present, however. A Boeing representative believes that it may be possible to fixture the water jets in some way that will reduce the possibility of the skin surface being damaged or workers being injured by the high pressure jets. He also wants to incorporate a system for collecting the water overspray so it can be returned for recycling.

Eastern airlines personnel also stated that they are interested in looking at high pressure water blasting but they have not done any experimental work so far.

Ultrasonics. Ultrasonic removal of paint was discussed with an engineer at Battelle who has been extensively involved in development of various ultrasonic tools. His judgment is that it is techniquely feasible to use ultrasonics to remove paint for aircraft skin. However, ultrasonics probably would

be used only as an aid to chemical stripper that could also act as a coupling agent between the transducer and the skin. In addition, ultrasonics would probably only be feasible in areas where the stripper will not by itself remove the paint. An example might be for removal of paint imbedded in the crevices around rivet heads. General stripping of an entire airplane by using an ultrasonic device does not appear to be economically feasible because the process would be slow.

Eastern airlines personnel stated that they plan to investigate ultrasonics in addition to the water jet idea for removing paint. However, they are in the idea stage only and have not done any experimental work.

Elevated Temperature. A brief laboratory experiment was run at Battelle to determine what effect heat would have on the painted surface of an airplane skin. A test specimen was provided to Battelle by Warner Robins ALC for this purpose. When applying heat directly to the sample a skin temperature level of about 225 to 250 degrees F was required to soften the paint sufficiently so it could be removed by mild abrasion with aluminum wool. However, even though the paint was softened by the heat, considerable scrubbing with the wool was still required to remove the paint.

A second approach was also tried that utilized heat as an aid to the paint removal process. A painted skin specimen was scraped with a spatula that was heated to 700-800 degrees. It was hoped that the blade edge would heat the paint so it could be easily scraped off while rapidly moving the scraper across the painted surface. However, in order for the scraper to be effective in removing the paint it had to be moved across the painted surface at a very low rate of speed. The high scraper temperature and low speed caused the skin temperature near the scraper contact line to be raised to 200-225 degrees.

The two trials that were run indicate that the skin surface must be raised to at least 200 degrees in order for the paint to be adequately softened to speed removal by abrasion. A 200 degree temperature level is probably high enough to damage some components immediately under the skin. In addition, the process of removing the heated paint would probably be slow and expensive.

It was observed during the skin heating experiments that a decal raised to a temperature of about 150 degrees was easily scraped off the skin. The adhesive material used to hold the decal in place did not scrape

off but remained on the skin after the decal was removed. Decal removal with heat may be practical if stripper does not sufficiently loosen the decals to make their removal easy.

Notable Differences Between Warner Robins Paint Stripping Techniques and those Observed Elsewhere

Although all stripping facilities removed paint from planes in much the same way (i.e., all used chemical strippers), the stripping operations varied from one facility to another. In all cases, some form of methylene chloride containing paint stripper is applied to the aircraft, allowed to work for a period of time, and then is removed by some procedure. Nevertheless, many differences have been identified which were considered for potential adoption at Warner Robins to possibly increase efficiency and lower costs. These differences are listed below.

Notable Differences in Stripping Technique

Equipment and Facilities

- The extensive use of scaffolding in tiers by some facilities to provide easy worker accessibility to surfaces to be stripped.
- The use of "cherry pickers" to bring workers into close proximity of aircraft surfaces.
- Use of wheeled vehicles on tracks that are controllable from boom-mounted personnel work baskets.
- The use of power ladders for access to aircraft surfaces.
- Lifelines for workers who walk over wing tops and other horizontal surfaces.
- The use of stacker cranes to bring workers into close proximity of aircraft surfaces. The cranes were supported on overhead rails and had a vertical column extending downward that supported the work platform or catwalk. The work platform had all cleaning, stripping, and washing equipment on it, or extending down the vertical column so no hoses extended to the platform from floor level.
- The use of overhead three degree of freedom mobile truss-like structures to bring workers in close proximity to the aircraft.

- o The use of a power buffing tool with disk pads similar to Scotchbrite to remove final amounts of difficult-to-remove paint.
- o Use of large central storage tanks instead of 55-gallon drums for supplying stripper.
- o Downdraft air provided in the stripping area to keep fumes to a minimum.

Operational Techniques

- o Prior cleaning with methyl ethyl ketone to obtain a good bond from masking materials.
- o The use of precut, masking, aluminized barrier paper.
- o Paint removal and repainting in same hanger (without moving aircraft) using same scaffolding.
- o The use of troughs and tubes alongside the fuselage to collect the spent stripper and paint in drums when scraped from the aircraft.
- o Maintenance of the aircraft while stripping and repainting is in progress.
- o Removal of chemical stripper and loosened paint from aircraft surface by a high-pressure (200 psi) water jet.
- o Washing with soap solution.
- o The use of the same labor force to both strip and paint aircraft in order to upgrade the job classification.
- o The upgrading of the paint stripping job classification by other means.
- o Use of a small crew on a 24-hour straight through shift at high (incentive) rate.
- o Yearly inspection of the paint condition on all aircraft and the incorporation of all information relative to painting into a computer system.
- o Leave hard to remove paint on aircraft surface and repaint over it.

Stripper Materials

- o Greater use of phenolic-type strippers (claimed to be stronger than nonphenolic types) by some facilities.

- o The use of acid-type strippers (claimed to be strongest of all strippers) either on substantial or limited scale by some facilities.
- o The use of a solvent-type secondary stripper (claimed to remove primer better and rinse from the plane cleaner.

Waste Disposal

- o Return of the used stripper to a chemical supplier for reclaim and salvage value.
- o Collection of all wash water and paint removed therewith in drums for disposal in a landfill.

Potential Changes to Improve Warner Robins ALC Airplane Paint Stripping Operation

The information gathered from site visits and telephone conversations disclosed nothing that can revolutionize the Warner Robins aircraft paint stripping operation. The information gathered has also shown that the Warner Robins operation appears to be essentially up to date in the state of the art. However, there are notable operational differences at a number of facilities and these have been listed in the previous section of this report.

The following paragraphs identify which differences offer some potential for improving the Warner Robins paint stripping operation and which do not. In addition, several items and practices were also noted during the airplane stripping operation observed at Robins AFB that could be modified to increase airplane throughput. These items are also identified in the following paragraphs and recommended improvements are described.

Equipment and Facilities

Worker Access Equipment. Extensive use of scaffolding around the plane is not recommended because the existing overhead platforms and elevator catwalks along with limited use of adjustable mobile floor stands can readily and efficiently reach the upper surfaces of the plane. The stabilized platforms and catwalks also provide worker mobility that permanent stationary staging does not provide.

The use of "cherry picker"-type vehicles is not recommended because their booms could easily damage the plane's surface and they are not expected to be as efficient as the overhead platforms and elevator catwalks presently being used.

The basic concept and design of the presently used overhead, stabilized platform system is good. The cages provide rapid three-directional movement capability and can cover most of a plane's upper surfaces without any interference with equipment located on the floor. Stacker cranes such as those used at Boeing and the overhead three degree of freedom truss work at Delta offer no real operational advantage over the cable-supported platforms at Warner Robins. The Boeing and Delta units provide a steadier work platform but they also have substantial structure that could damage the plane easier than the cables.

There are several modifications that can be made to the platform systems that are expected to increase their efficiency. (1) The platforms can easily be lengthened in the direction parallel to the longitudinal centerline of the plane to give the two occupants more room to work on the plane's surface without interfering with each other. (2) A set of controls mounted on the inboard side of the stabilized work platform would be easier to reach than the present outboard position.

The increase in platform length at each end should be sufficient to allow reaching areas under the tail horizontal stabilizer. By doing this the platforms could be made to cover the complete upper surface of the plane including the tail in case the tail catwalk staging were to break down. The ability to reach all areas of the tail is of course dependent on whether adequate overhead clearance for the platforms is available.

In the present operation the workers in the platforms hold stripper and water hoses that drag along as the platforms move through the air. The water and stripper hoses could be connected through quick disconnects to a manifold block rigidly mounted on the platform frame. With this arrangement the worker would not have to fight the hose as it was being dragged along during platform movement. Short hoses could be run from the manifold to each worker station thus making it possible for both workers to apply stripper and wash the plane together.

The catwalk staging at Warner Robins appeared to be somewhat narrow. It might be better if the catwalk were one or two feet wider. The extra width would provide more room for the workers to move past each other. Permanent multilevel tail staging similar to that used by Delta would be an alternative. The present staging provides vertical mobility to the worker and this is a major advantage. Also two or more workers could probably n effectively work on more than one staging level at a time because of falling debris.

By having stripper and water hoses attached through quick disconnects to a manifold block on the catwalk the workers would not have to support the weight of the hose which appeared to be substantial when the catwalk was high in the air. The water and stripper lines could tee off through the manifold block to provide stripper and water lines to both workers.

The use of power ladders is expected to improve the maneuverability of people on the floor. Instead of having to jack up and lower the unit by hand the worker could push a button or step on a foot control to raise and lower while standing on the work platform.

Central Stripper Supply System. Changing from a barrel supply system to a central supply system could provide the following advantages.

(1) Elimination of barrels from the stripping area.
(2) Elimination of the requirement to periodically move barrel pumps to full stripper barrels.
(3) Easy control of stripper temperature.
(4) Elimination of the small amount of stripper waste that occurs when a barrel is almost empty.

One disadvantage of a central supply system is that the versatility of quickly switching from one stripper to another is lost unless several storage tanks are used and it is possible to stock more than one material. This option is not available to Warner Robins.

Personnel at other stripping facilities have reported that stripper temperature is important because cool stripper does not work as fast as stripper at room temperature. If the storage tank were located outside it is recommended that the tank be jacketed with hot water, steam, or electric heating coils.

Lighting. Improved lighting is recommended under the wings of the plane. Addition of light to the under wing staging is expected to substantially improve visibility under the wings. Lights are recommended as a convenience to night crews working under the wings and are expected to result in their being able to better assess the stripper coat thickness, the stripper progress toward removing a coat of paint, and stripper removal during brushing and rinsing.

Lights should be installed along the edges of the staging deck and should have splash shields to protect them from stripper and water. Estimated spacing of about 10 feet is desirable.

Work Trench Beneath Fuselage. The area beneath the fuselage appeared to be a very difficult area to strip during the C141 stripping operation that was witnessed at Warner Robins. The paint on the lower fuselage of the plane observed was extremely difficult to remove. This is reportedly a frequent problem area on planes because it is a field maintenance area. At least part of the removal problem may be caused by the lack of working room under the fuselage. Men are forced to work from creepers because of the approximately 2 to 2-1/2 feet of ground clearance beneath the fuselage.

A trench under the fuselage is expected to substantially improve work conditions for stripping the belly of a C141 aircraft and should result in an improved job in that area.

A trench about 6 feet deep and 5 feet wide is recommended. The length should extend from just behind the nose wheel to where the rear fuselage curves upward. A spring loaded stop is recommended for the nose wheel bearing point at the forward end of the trench. A false floor of grating should be installed for the workers to stand on. The trench should be sloped so stripper and paint chips drain to one end. Installation of a sump at one end is recommended in case used stripper storage should become a desirable capability in the future. A flush line or nozzle should also be installed at floor level at the high end of the pit so high volume water flow can be used to flush the pit floor clean at the end of each day. Installation of removable grating is also recommended at the main floor level so the belly of a high ground clearance plane can be stripped from the main floor.

Powered Brushes. Powered brushes have been tried at Warner Robins but have not been well received by workers. It would seem that powered polypropylene brushes would have little effect on paint that is still tightly adhering to a plane's surface and that they would not be any more efficient than hand brushes or water spray in removal of loosened paint. In order to remove tightly adhering paint an aggressive cutting action is required. Braniff personnel like the powered disk with Scotchbrite pad that they use but they point out that it must be used with extreme care to prevent damage to the plane's surface. No other stripping facilities used powered brushes or pads.

Powered brushes are not recommended because soft polypropylene is not effective in removing tightly adhering paint and aggressive cutting material involves too much risk of damaging the plane's surface.

Operational Techniques

Many of the operational differences noted at other facilities are not applicable to Warner Robins' operation. These include (1) stripping and painting in the same area, (2) Doing maintenance tasks on the plane during the stripping operation, and (3) use of troughs taped to the side of the aircraft to run used stripper into barrels.

Operational techniques that are applicable to Warner Robins are in the areas of masking and personnel distribution. Discussions of potential changes to Warner Robins' operation in these areas are discussed below.

Masking. Loosening of masking tape from the plane's surface during the stripping process did not appear to be a problem at Warner Robins. However, if loosening of masking tape becomes a problem in the future, wiping the surface with methyl ethyl keotone before applying the tape may result in a better bond.

Several commercial airline stripping facilities use precut sheet barrier papers to speed the masking process on certain areas of the plane. This technique is applied especially around windows. Even though the planes stripped at Warner Robbins do not have areas such as passenger windows where the masking procedure is extremely repetitive it may be possible to employ the precut sheet technique to some advantage.

Warner Robins was observed to use multiple tape strips to cover cockpit windows. The window masking procedure took a substantial amount

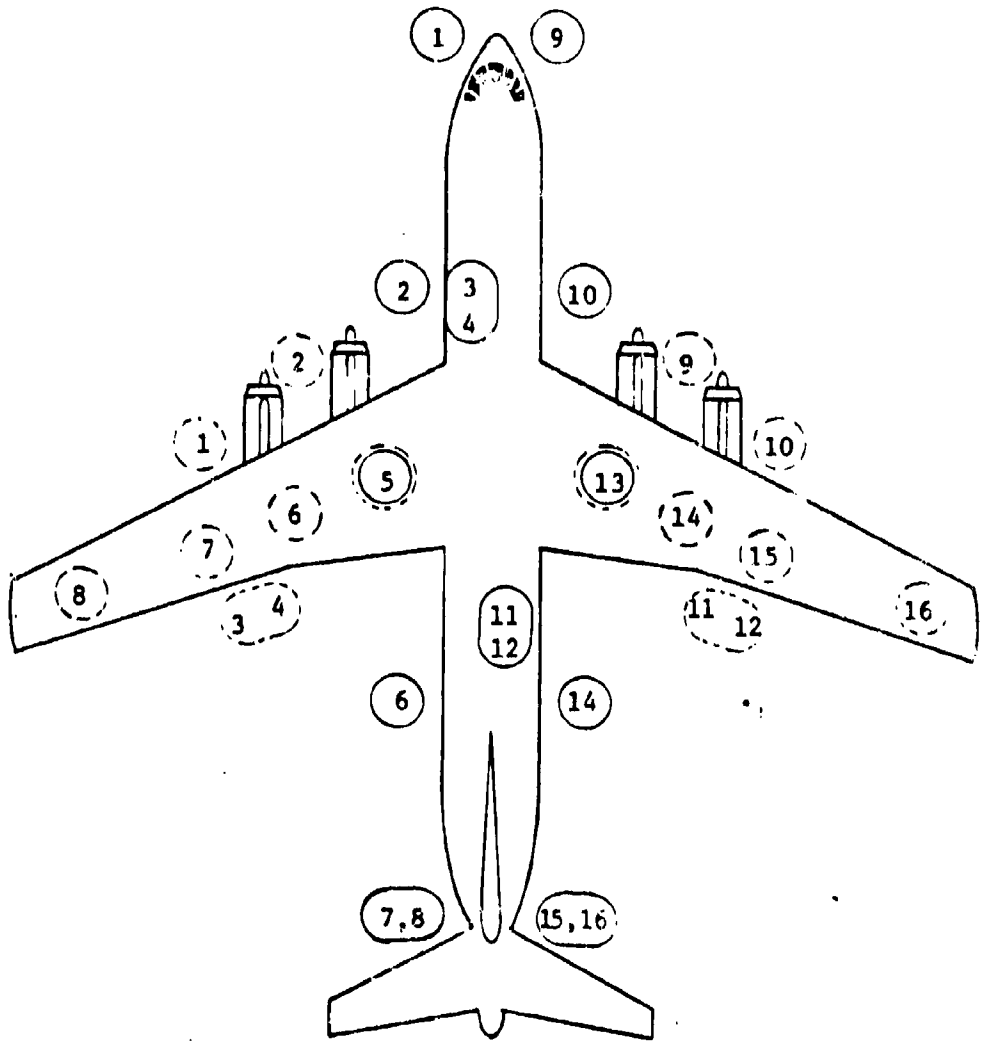
of time and may be justified because of window vulnerability to stripper. However, the tape strips were difficult to remove from the windows when stripping was complete. Precut barrier sheets could be taped over the windows around the edges. In view of the fact that the window frames are carefully hand-stripped after the windows are masked with tape strips and that a second masking sheet is then placed over the window area, the use of aluminum paper in lieu of tape for the primary masking would appear to be adequate, and should result in shorter masking time and make removal easier.

Personnel Distribution

The Warner Robins airplane stripping procedure, as observed, used defined area responsibility approach to get the plane stripped. Each of the three shifts had its area of plane to work (i.e., left wing, fuselage, and right wing) and personnel on the individual shifts had their assigned areas to work. This approach has an advantage in that each person knows exactly what his job is and he becomes familiar with his area on the plane.

During the plane stripping operation witnessed at Warner Robins a substantial amount of man-hours were lost while stripper was working on all sections of the aircraft and during the stripper application and brushing process on the fuselage because of interferences between personnel working the upper and lower portions of the aircraft.

By rearranging personnel work assignments Warner Robins may be able to increase the throughput of their stripping facility. Figure 21 shows how 16-day shift personnel are assigned to the aircraft. Figure 22 shows a rough flow chart of the work assignments carried out by the day shift on the plane that was observed being stripped at Warner Robins. It should be emphasized that this was not a detailed time study. Consequently, the times stated for tasks being completed are approximate because the average task startup and completion times for all 16 people were estimated. The purpose of the work flow chart is to show a trend and not exact elapsed time required for specific tasks. It can be seen that there are approximately 1.6 hours spent waiting for stripper to work on the paint. This translates to 26 man-hours for a 16-man crew. This time could have effectively been used to mask or strip the left wing or right wing. Figure 21 shows potential alternate assignment areas that could be used to fill slack time. There was other idle time lost during the afternoon period that does not show up on the work flow chart because some men finished their tasks before others.



Man	Primary Work Area ○	Alternate Work Area ◌
1, 9	Nose	Engine Pod & Pylon
2, 10	Lower Forward Fuselage	Engine Pod & Pylon
3, 4, 11, 12	Upper Fuselage	Over Wing
5, 13	Lower Underwing Fuselage	Under Wing
6, 14	Lower Rear Fuselage	Under Wing
7, 8, 15, 16	Tail	Under Wing

FIGURE 21. DAY SHIFT WORK AREAS

FIGURE 22. DAY SHIFT WORK FLOW CHART
(16 PEOPLE)

Fuselage Masking Begins	7:45 am
Fuselage Masking Complete	9:30 am
Break	9:40 am
First Coat of Stripper Being Applied	10:00 am
First Coat of Stripper Application Completed	10:45 am
Waiting for Stripper to Work	10:45-11:45 am
Lunch	11:45 am - 12:30 pm
Begin Brushing First Coat of Stripper	12:30 pm
First Coat Stripper Completely Removed except tail (fuselage was washed, and tail squeegeed)	1:10 pm
Second Coat of Stripper on Plane	2:00 pm
Waiting for Stripper to Work	2:00-2:40 pm
Break	2:40 pm
Second coat of Stripper Being Brushed and Removed	3:00 pm
Area Cleanup Completed	3:40 pm
Shift Change	

Because of cold weather conditions 17 people were used on the swing shift. A normal shift was reported to be about 10 people. During the masking everyone was busy until about 6:00 pm when the first break was taken. However, 3 people applied stripper which took about 20 minutes and everyone was idle for about 40 minutes while the stripper was working. This time could have been used to assign idle crew members to spot stripping on the fuselage or working on the right wing.

It is recommended that Warner Robins try to strip three or four planes using the alternate work assignment approach in which stripping personnel are assigned to another task temporarily when they cannot work in their primary assignment location. After that period, an evaluation can be made of increased efficiency obtained. Because available alternate work will vary substantially as the stripping process proceeds this approach will require close supervision by shift foremen. It will also require additional worker initiative because workers will have to recognize when slack times are imminent and when their primary responsibility area of the plane is ready to be worked again. In actual practice, this "extra responsibility" is part of the present job descriptions. If increased demands are placed on the workers it may be necessary to upgrade them to a higher pay level. Boeing and United both use upgraded or higher paid people in their stripping operation and report that results have been very good.

Boeing Used

Stripper Materials. Advantage should be taken of use of the most efficient stripper for each aircraft to be stripped. At some convenient time before the actual stripping begins several approved strippers (selected from prior testing and performance experience) should be spot tested on the aircraft. Both the reports received from the field, and the laboratory evaluation of strippers at BCL indicate that considerable variation in performance of strippers can be expected, depending upon particular coating to be removed and other extraneous conditions. Thus, it is highly desirable to match the most efficient stripper to each particular job.

Waste Disposal. It is recommended that Warner Robins investigate other methods of waste disposal than through the base sewage treatment plant. Disposal by landfill or through a reclamation company may provide greater flexibility as to which type of stripper can be used.

If an alternate disposal method is selected it is recommended that a sump be built into the trench beneath the fuselage so bulk collection is possible. Picking stripper up and putting it in barrels as is done at several commercial stripping facilities is not recommended.

PLAN FOR IMPROVING EFFICIENCY OF DEPAINTING AIR FORCE AIRCRAFT

Introduction

This plan for improving efficiency of stripping coatings from Air Force aircraft was prepared following a study of methods used by other air bases, commercial airlines, and contract strippers. The objective of the study was to identify proven methods of stripping aircraft coatings which are superior to methods used by the Air Force, and which could be adopted by the Air Force to increase efficiency.

This study has shown that methods used by the various air bases are basically the same as those used in the airline industry and at Naval facilities. Differences that exist are of a minor nature and none can be categorically adopted by the Air Force to advantage. These differences may be summarized briefly as follows.

Equipment and facilities differ from place to place. Equipment differences include scaffolding, "cherry pickers", power ladders, stacker cranes, and other devices to promote easy access to work surfaces by the labor force. None of these assists provide obvious advantages over the stabilized work platforms used by Warner Robins. Nevertheless, this plan suggests changes in Warner Robins' work platforms that may improve efficiency.

Differences in operational techniques include slight differences in stripper application, amount of agitation of strippers, dwell time before the first coat of stripper is removed, the way in which wash water is used, etc. No one procedure can be identified as being clearly superior to the others. Basically, the operational procedures used are largely a matter of individual preferences, and have evolved through use under localized conditions.

The same stripper materials are available to all civilian stripper installations but there is some restriction placed on the Air Force by T.O. 1-1-8. There are differences of opinion regarding the relative effectiveness of various strippers, but it is generally concluded

that the relative order of strength is (1) acid type, (2) phenolic type, and (3) non-phenolic type. Acid type is ruled out by the Air Force because it promotes stress corrosion cracking of high strength steel. However, it might be used advantageously but with care in some localized trouble spots. There can also be advantages in using the best phenolic strippers in place of non-phenolic types where arrangements for proper disposal of used stripper can be made.

There are variations in employment of the labor force from place to place. These variations include using the same workers to strip and repaint aircraft (with upgraded job classification for stripping), and the extreme of paying by the job and working around the clock until the job is done. Adoption of these methods (employed elsewhere) are of doubtful value to the Air Force. Nevertheless, some potential for more effective use of labor force has been identified and incorporated into the plan.

Paint stripping techniques that are clearly superior to the methods used at Warner Robins were not observed at other airplane stripping installations. Had such methods been identified, the proven savings would have been compared with the estimated cost of making the change, and the payoff calculated. Because proven superior methods have not been identified, this plan is based on changes which have been identified as offering a potential for increasing efficiency at Robins Air Force Base, but which have not been proven in use. Payoff is based strictly on rough estimates, and not on proven experience. Additional study is mandatory before making decisions regarding any substantial investments to incorporate the plan. Consideration must be given to worker motivation since changes suggested are designed to increase worker output.

Recommendations for Improving Warner Robins' Airplane Depainting Operation

Recommendations for improving the Warner Robins' aircraft depainting operation are described below. Economics and convenience for workers were considered to be very important in selecting improvements that are recommended. However, the main objective is to speed up the

stripping operation so more planes can be run through the facility. When calculating estimated cost savings that may be realized by implementing proposed facility and operational changes, it was assumed that 60 planes per year would be run through the stripping facility and that labor cost is $12.10 per hour (a 10 percent increase over Warner Robins' reported FY77 labor costs).

It will become apparent in the following paragraphs that a substantial increase in operational efficiency can be obtained by merely modifying the way in which personnel are utilized on the plane. Other recommended modifications to equipment, facilities, and operational techniques will also have some effect on stripping efficiency but not nearly as much as the change in personnel utilization. Estimates of implemention cost and man-hour savings are estimated for each of the proposed changes to Warner Robins' stripping operation. It should be noted that the predicted man-hour savings were obtained through necessarily subjective estimates and that actual savings may vary substantially from the predicted values. In addition, the cost estimates for implementing the suggested changes are rough orders of magnitude only and are not based on an extensive conceptual design of hardware modifications or additions necessary for implementation.

Personnel Utilization

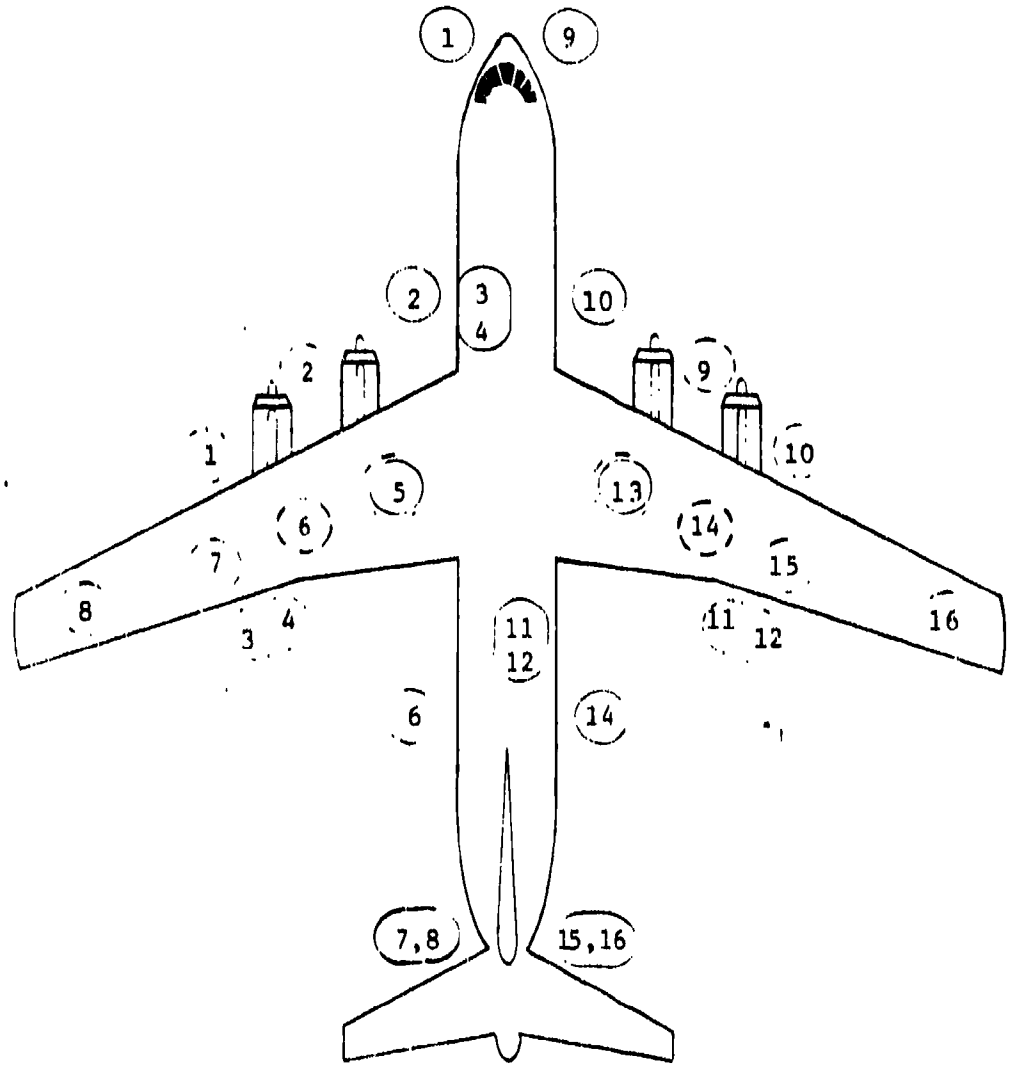
The Warner Robins airplane stripping procedure uses a sharply defined area responsibility approach to get the plane stripped. Each of the three shifts has its area of the plane to work on (i.e., left wing, fuselage, and right wing) and personnel on the individual shifts have their assigned areas to work. This approach has an advantage in that each person knows exactly what his job is and he becomes familiar with his area on the plane. However, a substantial number of man-hours were lost on the C141 stripping operation observed at Warner Robins because the personnel did not perform other tasks while the stripper was working on the aircraft. An additional smaller amount of time can be lost during the stripper application and brushing process because of interferences between personnel.

By rearranging personnel work assignments Warner Robins should be able to increase the throughput of their stripping facility. Figure 23 shows how 16-day shift personnel are assigned to the aircraft. Figure 24 shows a rough flow chart of the work assignments carried out by the day shift on the plane that was observed being stripped at Warner Robins. It should be emphasized that the times stated for tasks being completed are only approximate because the average task startup and completion times for all 16 people were estimated. The purpose of the work flow chart is to show a trend and is not a summary of exact elapsed times required for specific tasks. It can be seen that there are approximately 1.6 hours spent waiting for stripper to work on the paint. This translates to 26 man-hours for a 16-man crew. There was other idle time lost during the afternoon period that does not show up on the work flow chart because some men finished their tasks before others. This time could have effectively been used to mask or strip the left wing or right wing. Figure 23 shows potential alternate assignment areas that could be used to fill the day shift's slack time.

Because of cold weather conditions 17 people were used on the swing shift. A normal shift was reported to be about 10 people. During the masking process everyone was busy until about 6:00 pm when the first break was taken. However, 3 people applied stripper which took about 20 minutes and everyone was idle for about 40 minutes while the stripper was working. This time could have been used to assign idle crew members to do spot stripping on the fuselage or work on the right wing.

It is recommended that Warner Robins try to strip three or four planes using the alternate work assignment approach in which stripping personnel are assigned to another task temporarily when they cannot work at their primary assignment location. After that period, an evaluation can be made to determine increased efficiency realized. Because available alternate work will vary substantially as the stripping process proceeds this approach will require close supervision by shift foremen so effective alternate assignments can be made.

Assuming that a day shift crew size of 16 people and night shift crew size of 10 people are normal, it is estimated that approximately 90 man-hours per plane or $65,000 per year can be saved if the crews are



Man	Primary Work Area ○	Alternate Work Area ◌
1, 9	Nose	Engine Pod & Pylon
2, 10	Lower Forward Fuselage	Engine Pod & Pylon
3, 4, 11, 12	Upper Fuselage	Over Wing
5, 13	Lower Underwing Fuselage	Under Wing
6, 14	Lower Rear Fuselage	Under Wing
7, 8, 15, 16	Tail	Under Wing

FIGURE 23. DAY SHIFT WORK AREAS

FIGURE 24. DAY SHIFT WORK FLOW CHART
(16 people)

Fuselage Masking Begins	7:45 am
Fuselage Masking Complete	9:30 am
Break	9:40 am
First Coat of Stripper Being Applied	10:00 am
First Coat of Stripper Application Completed	10:45 am
Waiting for Stripper to Work	10:45-11:45 am
Lunch	11:45 am - 12:30 pm
Begin Brushing First Coat of Stripper	12:30 pm
First Coat Stripper Completely Removed except tail (fuselage was washed, and tail squeegeed)	1:10 pm
Second Coat of Stripper on Plane	2:00 pm
Waiting for Stripper to Work	2:00-2:40 pm
Break	2:40 pm
Second coat of Stripper Being Brushed and Removed	3:00 pm
Area Cleanup Completed	3:40 pm
Shift Change	

assigned to alternate work locations on other areas of the plane when stripper is working or during other slack times. This is of course theoretical and is highly dependent on worker acceptance of the proposed alternate work plan.

Equipment and Facilities

Stabilized Work Platforms. Redesign the stabilized work platforms so they are approximately 8 feet x 16 feet with the long side being parallel to the fuselage of the plane. A suggested configuration for the redesigned stabilized work platform is shown in Figure 25. In order to provide extra versatility, the platforms should be made long enough so the occupants can reach all surfaces on the tail under the horizontal stabilizer (Figure 26). The entire tail section can then be stripped by workers on the work platforms if the tail staging should happen to break down. Increasing the platform length may seriously affect the balance of the stabilized platform and should be analyzed thoroughly before a final decision is made.

Two workers occupy the stabilized work platforms in the present stripping operation at Warner Robins. One of the men spends a major portion of his time driving the platform while the second man works the plane's painted surface. This results in a substantial number of man-hours being lost due to the driver being inactive. In order to eliminate most of the lost man-hours, it is recommended that the controls be on the inboard side (on the side next to the plane) of the platform so either worker can control basket movement without moving from his work station. The type of controls recommended are a push-button type that are push/on, release/off. Depressing the buttons half way could energize a slow movement mode. The controls should be waterproof.

In the present operation, one platform occupant holds onto a stripper or water rinse hose and sprays the plane's surface while the other occupant drives the platform. The hose man has to support the hose weight as the platform moves through the air. It is recommended that stripper and water hoses be connected through quick disconnects to a

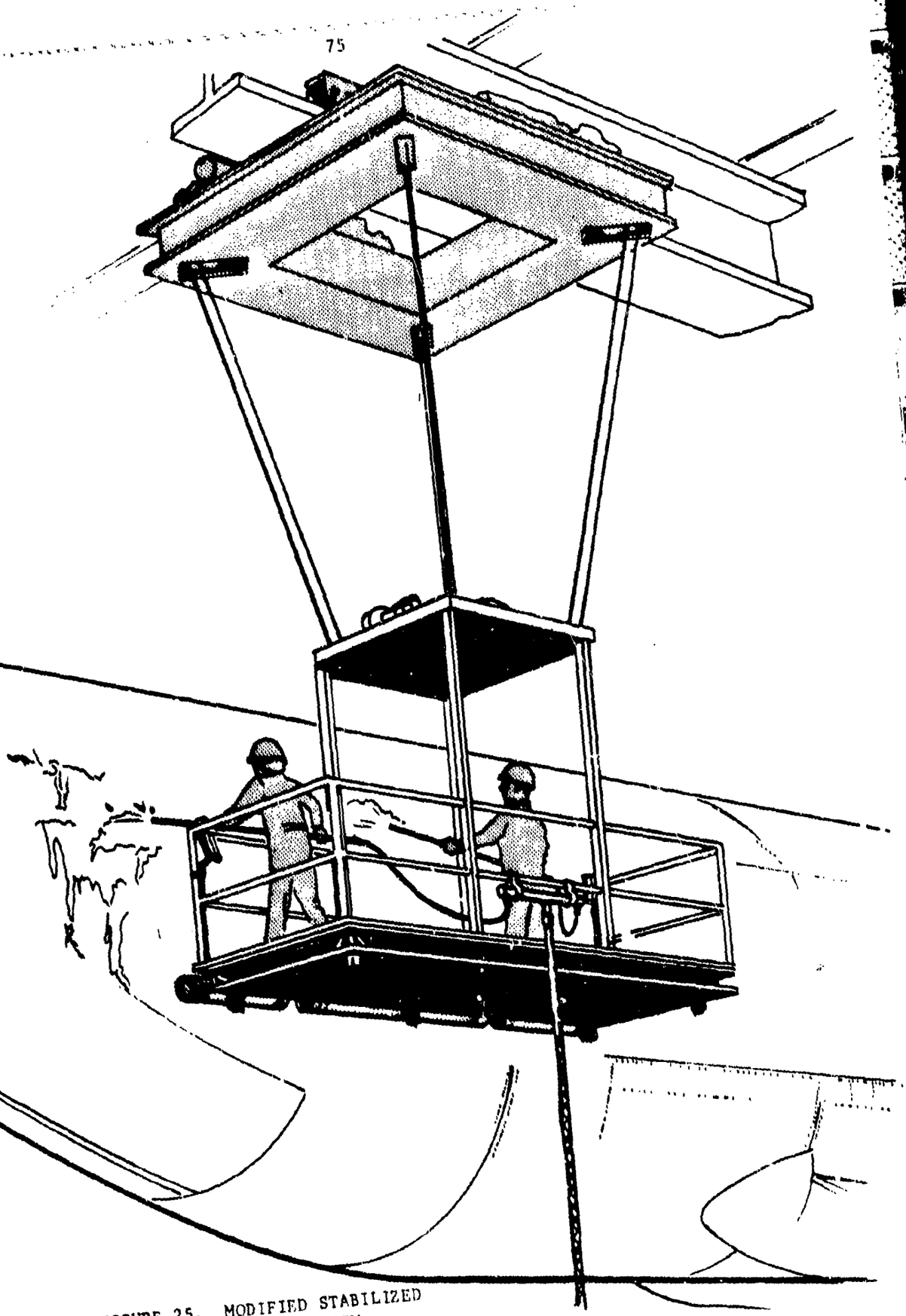


FIGURE 25. MODIFIED STABILIZED WORK PLATFORM

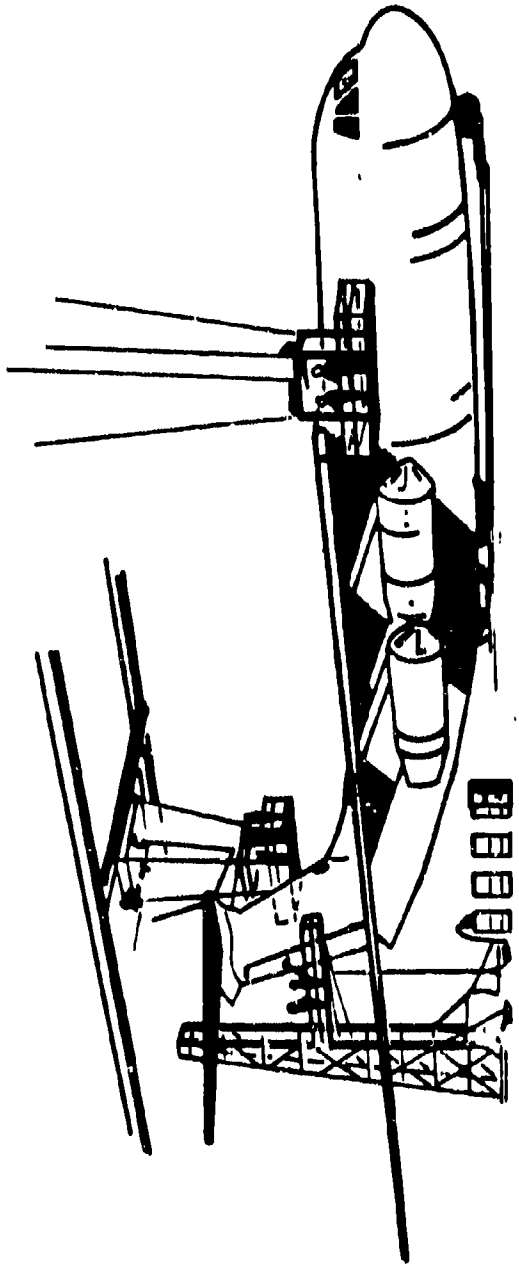


FIGURE 26. STABILIZED WORK PLATFORM AND TAILSTAGING

manifold block mounted on the platforms to eliminate the inconvenience of the worker having to support the hose hanging to the floor. Swivel joints and strain reliefs should be installed at the hose/manifold connection point. Short lead lines should tee off the manifold to each worker to provide both of them with stripper and wash water services.

It is estimated that reshaping the platforms, moving the controls to the inboard side, and installation of the water and stripper lines can increase one platform's occupant efficiency as shown below:

Task	Man-Hours Saved per Plane
Mask	0.25
Stripper Application	1.75
Stripper Agitation	0.75
Stripper Removal	0.50
Demasking	0.10
Total Savings	3.35 Man-Hours

The modifications are expected to save approximately $2,400 per year per platform.

The estimated cost of implementing the recommended modifications is expected to be about $6,000 per platform giving a projected payout of 2.5 years. Not reflected in the cost is the increased versatility gained by making the platforms longer so all tail surfaces can be reached.

Tailstaging. The present tailstaging is good because it covers the entire tail and provides worker mobility. However, as with the platforms, the catwalk requires an operator much of the time while the second occupant works the plane's surface. It is recommended that the following modifications be made on the tailstaging to make them more efficient.

1. Increase the catwalk width to approximately 5 feet to provide more working room and increase safety. The width increase is expected to result in an increase in catwalk weight. The effect of the additional weight on

the operational characteristics of the tailstaging structure should be analyzed in detail.

2. Investigate the possibility of moving the catwalk vertical movement controls about half way out on the catwalk so either worker can operate the controls without moving from his work station. It has been reported that the present controls are located at the pivot end of the catwalk to minimize the possibility of the catwalk being moved while a worker is entering or leaving catwalk. This safety question should be carefully evaluated in detail before controls are moved.
3. Install stripper and water manifold blocks for attaching stripper and water feed lines on the catwalk so the worker does not have to support the hose weight
4. Route short hoses from the manifold block to each worker so they can both apply stripper and rinse the plane.

It is estimated that the above tailstaging modifications will result in the following man-hour savings for two tailstaging workers on one catwalk.

Task	Man-Hours Saved per Plane
Masking	0.50
Stripper Application	1.00
Stripper Agitation	0.50
Stripper Removal	0.50
Demasking	0.10
Total Savings	2.60 Man-Hours

Therefore, the tailstaging catwalk modifications are expected to save approximately $1,900 per year per catwalk.

The estimated cost of implementing the recommended changes to the tailstaging is approximately $8,000 per catwalk giving a projected payout of 4.2 years.

Mobile Power Scaffolding. Mobile scaffolding is presently being used at Warner Robins to provide floor workers access to the plane's surfaces that are approximately 8 to 15 feet off the floor. The present scaffolding is raised by means of a hydraulic hand-operated pump, and is moved about by manpower. Both operations are time-consuming. Use of electric-powered mobile scaffolding would allow a worker to adjust stand height while he is stationed on the work platform. In addition, some models of powered scaffolding are capable of being moved or driven while the operator is on the work platform.

Substituting four powered mobile scaffolds that can be raised, lowered, and driven by a work platform occupant is expected to save about 6 man-hours per plane for a yearly cost savings of approximately $4,356. The estimated cost of purchasing four power scaffolds is approximately $30,000 giving a payout of 6.89 years.

Lighting. Addition of lights to the under wing staging is expected to improve visibility under the wings. Lights are recommended as a convenience to night crews working under the wings and are expected to result in a better assessment of the stripper coat thickness, the stripper progress toward removing a coat of paint, and stripper removal during brushing and rinsing. Explosion and waterproof lights should be installed along the edges of the under wing staging deck and should have splash shields to protect them from stripper and water. Estimated spacing of about 10 feet is desirable and approximately 14 lamps would be required.

It is estimated that the main savings will be gained during the stripper agitation and removal process resulting in a savings of approximately 3-4 man-hours per plane or $2,500 per year. The estimated cost of installing improved lighting is approximately $14,000 resulting in an expected payout of 5.60 years.

Work Trench Beneath Fuselage. Presently, men working the belly of the plane are forced to work from creepers because of the small clearance between the C141 and the floor. This is an extremely difficult work location. Paint removal on the belly is further complicated because it is a

field maintenance area where paints may be applied in the field that are very difficult to strip.

A trench under the fuselage is expected to substantially improve work conditions for stripping the belly of a C141 aircraft and should result in an improved job in that area. A trench about 6 feet deep and 5 feet wide is recommended. The location of the trench is illustrated in Figure 27. A spring-loaded stop is recommended for the nose wheel bearing point at the forward end of the trench. A false floor of grating should be installed for the workers to stand on. The trench should be sloped so stripper and paint chips drain to one end. Installation of a sump at one end is recommended in case stripper and paint waste storage should become a desirable capability in the future. A flush line or nozzle should also be installed at floor level at the high end of the pit so high volume water flow can be used to flush the pit floor clean at the end of each day. Installation of removable grating is also recommended at the main floor level so the belly of a high ground clearance plane can be stripped from the main floor.

It is expected that stripper fumes may be a serious problem in the trench and that a trench ventilation system may be required to control buildup of fumes. In addition, it may be necessary for trench workers to wear respirators.

It is estimated that approximately 4 man-hours per plane or $3,000 per year can be saved by installing the trench. In addition better or more complete paint removal is expected because of the improved working position.

The estimated cost for installing a trench is approximately $70,000 which results in a projected payout of 23.3 years.

Operational Techniques

Stripper Selection. The best stripper for each aircraft to be stripped should be selected by spot testing at some convenient time before the actual stripping is to commence. Those strippers to be examined should be ones proven from prior testing and actual experience. Matching the

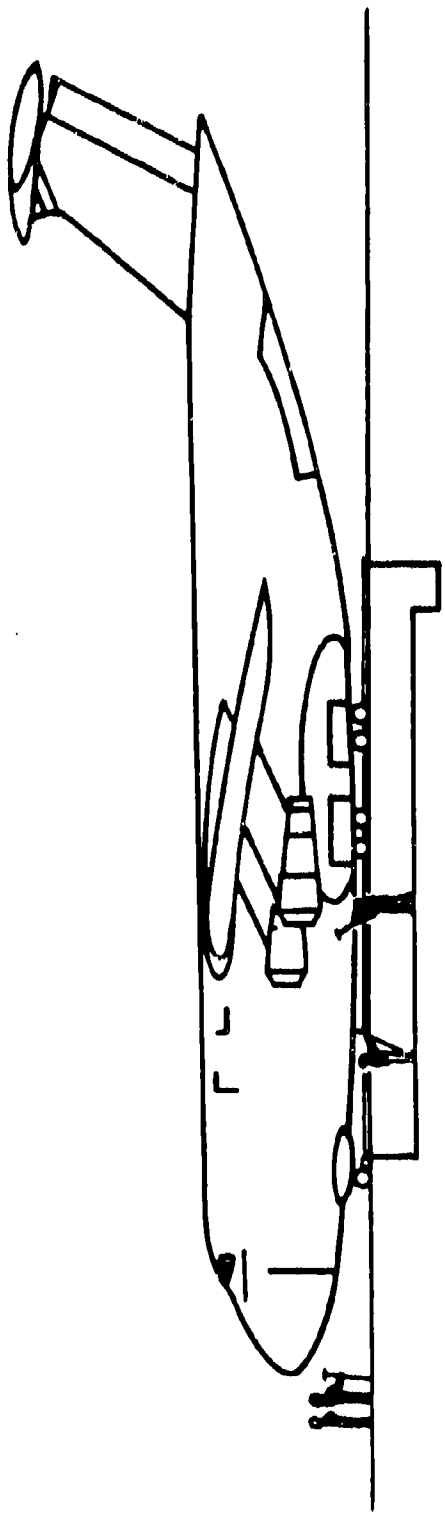


FIGURE 27. WORK TRENCH

stripping material to the job at hand can do much to increase the efficiency of paint removal.

It was reported that 16 barrels of phenolic stripper were used on the plane observed being stripped at Warner Robins and that 30 barrels is the normal volume when non-phenolic stripper is used. Although phenolic strippers are not necessarily all better than non-phenolic strippers, this experience illustrates that substantial material savings can occur if the best stripper is selected to strip a plane.

Assuming that 5 barrels of stripper can be saved per plane by preliminary spot testing and that stripper costs $3 per gallon, a yearly savings of $50,000 can be realized. It is expected that the spot testing could easily be accomplished within 4 man-hours per plane or a cost of $3,000 per year.

The above cost considerations do not account for variable disposal costs for different types of strippers and do not include potential cost savings that may be realized because of increased stripping efficiency.

Waste Disposal. It is recommended that Warner Robins investigate other methods of waste disposal than through the base sewage treatment plant. Disposal by landfill or through a reclamation company may provide greater flexibility as to which type of stripper can be used.

If an alternate disposal method is selected it is recommended that a sump be built into the trench beneath the fuselage so bulk collection is possible. Picking stripper up and putting it in barrels as is done at several commercial stripping facilities is not recommended.

APPENDIX A

INFORMATION GATHERED BY VISITS AND TELEPHONE CONVERSATIONS WITH AIR BASE PERSONNEL

APPENDIX A

INFORMATION GATHERED BY VISITS AND TELEPHONE CONVERSATIONS WITH AIR BASE PERSONNEL

Paint Removal at McClelland A.L.C., Sacramento, California

The discussion of paint stripping was held in Lee Morse's office and he was kind enough to bring in the chemists, the base waste treatment operator, and the industrial engineer to answer our questions. The process and material descriptions which they operate to are being revised but they said they had a copy close enough to their current operation which they could send to us.

The following types of aircraft are stripped and repainted at McClelland:

(1) F-106
(2) F-105 (occasionally)
(3) Helicopters.

In addition, future plans include stripping and repainting F-111's. These plans call for the use of mechanical stripping methods but this may change.

Paints being stripped are polyurethane MIL-C-83285 over epoxy-polyamide primer MIL-P-23377. Paints supplied from different manufacturers to meet the above specifications vary considerably in their ease of stripping.

Strippers used are Turco 5873 and Eldorado PR-3400 (methylene chloride with no phenolic). Eldorado PR-3400 is causing problems in the industrial waste disposal systems. Occasionally Turco 5351 (methylene chloride with pehnolic) is used for hard-to-strip aircraft.

All areas which might be damaged by the stripping chemical are masked with 3M aluminum tape. The aircraft is not washed before stripping.

The stripper is sprayed on and left until it starts to work (approximately 1/2 hour). The stripper may or may not be brushed depending upon circumstances. Sometimes polypropylene bristle brushes are used. At other times they simply squeegee the aircraft. About 200 gallons of stripper is used on the average. Some workers may use aluminum wool. The craft is cleaned down to bare metal.

Finally, the craft is sprayed with warm water (about 110 F) using 110-120-lb pressure. A solvent is used to wash out the wheel wells.

One hundred fifty-six man-hours are allotted for mask/strip/unmask/alkaline wash. McClelland is about 95% efficient in meeting this allotment. Comparison of times with requirements of other bases is difficult because the 156 hours does not include the preparation of the surface for painting.

There is nothing unusual in the process we observed. McClelland has one wash rack which is in the same hangar in which the F-111 aircraft fuel tanks are cleaned. There was an aircraft in the hangar which had been stripped, it looked very good and the hangar had been cleaned up completely. Some controlled surfaces which were still in process of being stripped gave us an idea of the appearance of the stripper and the process. This operation is, of course, messy looking and apparently causes some people to feel that it is inefficient or difficult because of the mess, yet they seem to have each of the operations well under control, and the stripping seems to be quite effective.

The plant disposal system can handle up to three barrels per day of phenol. It is a batched treatment plant and is being very closely monitored by the local EPA. The operator of the treatment plant is a very practical chemist and pointed out that phenols are not nearly the problem some people think. He points out that the phenol which may constitute 30 percent of the material as it does on the airplane, oxidizes and is neutralized as it combines with the paint. He feels that as the material is worked and then rinsed with water it is reduced to about 5 percent of the waste coming from the wash rack. He does not consider this very much of a problem. He is concerned with other material; for example, the kind of problem caused when they changed stripper without notifying him. As a result he sometimes gets strange pollutants in the water that he did not understand. During this meeting he was able to communicate with the group assembled and find out what was going on. The meeting was an occasion for much internal communication regarding the material changes and the effect on the waste treatment plant.

The operator of the waste treatment plant did caution us not to write a rigid procedure for stripping aircraft into our final report. He pointed out that each base has slightly different requirements regarding aircraft paints and waste treatment and therefore, they require flexibility. We assured them it was not our intention to do anything like that and pointed out that our work statement tasks us to look for improvement in the operation where we might find them.

In general, the methods used at McClelland are similar to those used at Warner Robins except on a smaller scale. Because the aircrafts are so much smaller, McClelland does not use the mechanical assists used at Warner Robins to bring workers into working proximity of the aircraft.

Col. Wolverton in a separate interview mentioned a problem regarding specification materials. He says the Air Force has a problem because of the broad range of paints and strippers which meet the specs but for which performance cannot be predicted. The paint does not adhere well on some aircraft but in other situations the airplanes are difficult to strip with the available materials because of difference in the paints. This is the major problem because each aircraft has to be handled slightly different according to the judgement of the foreman. Therefore, hard and fast standards cannot be set for the operation.

Paint Removal at North Island
Naval Air Station, San Diego, California

The aircraft stripped and repainted at North Island are F-4, E-2, C-2, and H-46 (Helicopter). Paints stripped are polyurethane (MIL-C-81733) over epoxy primer (MIL-P-23377).

The following stripping compounds are used. MIL-R-81294, a neutral, methylene chloride-phenol stripper and MIL-R-81903, an acidic methylene chloride phenol stripper. The acid is hydroxyacetic. We were also told about a new product, Turco 6017, which is a nonphenol acidic stripper. It is claimed to work faster than the other strippers.

The airplane is coated with the stripper which is rubbed around with wire bristle brushes (type used by platers). They are allowed aluminum, brass, or stainless steel brushes. The stripper is allowed to remain on the airplane for some time until it has worked. The areas which do not appear to be stripping are rubbed with the brush to break through the paint and get the stripper in contact with the fresh surface.

The Navy has special problems with stripping because their aircraft may at times be recoated as many as 8 times prior to stripping. Another problem is that the stripper sometimes works too fast on the topcoat and leaves the primer behind. They then have to go back and remove the primer. The airplane is stripped to the bare metal.

North Island has 12 cells (so called) which are large hangars dedicated to paint stripping 100 percent of the time. There are other cells for painting the airplane in which the temperature can be raised to 125 degrees. The stripping rooms (or hangars) had hose reels on the walls that supplied the stripper from outside storage tanks to the stripping area. Some hoses were used to supply water and steam. In one area where an airplane was being stripped there was a large tangle of hoses on the floor. However, North Island had planned an excellent setup. Some of it was a little over exotic, and a change had to be made from electric solenoid valves to hand operated valves on the hose reels. Other than that it seemed to work fine.

Water-entrained steam is used to remove the paint stripper from the airplane. Squeegees are not used. When the airplane has been stripped satisfactorily and reworked a couple of times, the residue is blasted off with the steam-entrained hot water and rinsed. The airplane is then ready for an alodine treatment, following a wash treatment with some alkaline cleaner. At North Island it takes 5-8 people on two shifts, four days to mask, strip, and prime an E2A or B plane.

One of the most important bits of information provided concerns the use of ice or dry ice to blast paint from aircraft. Mr. Pichon said that he had tried this many years ago (he's been in the business for 28 years) and that it was an unqualified disaster.' It doesn't work! He discussed the objection regarding the amount of time that would be required to blast an airplane clean when one can only clean a spot an inch to an inch and a half in diameter at a time. The other important point is that the surface of the airplane can be damaged.

A vacuum blaster for blasting with walnut shells and apricot pits has also been tried in the past. Walnut shells are not as good as apricot pits. Presently, abrasive blasting is used on landing gears and solid parts of the aircraft where a dry stripper method is wanted because of the various seals and varying surfaces that have to be contended with.

North Island has also tried using ice; Turco did this some years ago for them. Dichromate has been added to the water to lower the freezing point. This was used to blast paint off of an F-4 tail. The paint was removed but the honeycomb structure underneath the skin showed through the skin. It is obvious that the force required to beat the paint off the surface was also enough to beat the metal into whatever was underneath it. The same thing was tried on a helicoptor rotor blade where the skin is even thinner. However, it beat the skin down between the ribs forming depressions along the blade length.

North Island has also tried stripping radomes with particles of apricot pits, which worked fine as long as they could very carefully direct the abrasive blast tangential to the surface. If the gun was pointed at the surface at any large angle up to 90 degrees, a hole would be blasted in the skin of the radomes. Blasting was just too critical for use in the shop.

Paint Removal at Alemeda Naval Air Station

Alemeda Naval Air Rework Facility strips and repaints the following aircraft: A-4, A-6, A-7, P-3, S-3, and some C-118, C-130, and other miscellaneous aircraft.

The paints on these aircraft are polyurethane topcoat (MIL-C-81773) over epoxy primer (MIL-P-23377). The strippers used are MIL-R-81294 and MIL-R-81903. Alemeda personnel are not hesitant to use phenolic-containing strippers because the waste from Alemeda is sent to landfills in drums. However, there was great concern about future disposal at landfills.

The facility was found not to be unusual. There were large hangars in which aircraft were being stripped but the materials and procedures were similar to that found in San Diego Naval Air Station.

The operation appears reasonable despite Mildred Patterson's concern about worker motivation. In truth, the operation seemed quite effective. We observed a P-3, which was a Lockheed Electra, with stripper in action. The material falls to the floor and appears messy but actually is quite effective. The workers were not in evidence at the moment because the stripper had been spread on the airplane and was in the process of working. We found nothing new or unusual in their process. They did have the same complaint, however, about material as we heard at McClelland AFB.

Mrs. Patterson has traveled to Europe and visited operations where aircraft were being stripped. Her current assignment is on plating operations but because she was in charge of aircraft stripping operations for many years, she has a lively interest in it. She extols the approaches that she found in Germany in Lufthanza and in England at BOAC and also at KLM in Holland. She rated them quite highly and gave us the impression that they had some special approach that was different than what we do in this country. In fact, she felt that the Europeans were way ahead of most of the U.S. bases and airlines in paint stripping. The differences are in equipment to bring the workers into close proximity with the painted surfaces of the aircraft. They have extensive work stand setups to make it easy for many workers to work on the aircraft at once and they are conservative of material, including water. Nevertheless, the materials and the procedures are similar to those used in the U.S. The water, however, is collected and separated and reused as much as

possible. After the discussions, we concluded that there were no unusual approaches used in Europe which are not being used in some of the better U.S. installations other than their housekeeping, which would follow from the conservative use of materials in Europe.

Subsequently, we found that United was probably equal or superior to the Europeans in providing ways for the workers to easily reach the painted surfaces of aircraft. In fact, the Europeans had gotten many of their ideas from United according to personnel interviewed there.

Paint Removal at Naval Air Station, Jacksonville, Florida

The Naval Air Station, Jacksonville, Florida, is one of nine rehab centers. Aero personnel (Lake City, Florida) consider NAS to be one of the most advanced stripping operations in the country. The stripping and painting of aircraft is under the direction of Mr. L. J. Barilla, Production Superintendent. The NAS main work load is with the A-7 and P-3, but considerable work is also done with other craft such as the RA5C and S-2. Most repainting jobs cover 100% of the aircraft, although occasional limited jobs are also specified.

The most outstanding feature of the NAS operation is a new (4 years old) building containing four huge bays used for progressive stages of depainting. The entire building is equipped with sophisticated air pollution abatement equipment. Each of the four bays can be closed off with sliding aluminum doors and some can be subdivided for alodizing two planes at the same time. The bays are used for: Bay (1), masking; Bay (2), stripping; Bay (3), blasting as required (for example, 270-mesh glass bead-blasting to remove corrosion along seams); and Bay (4), alodizing. All strippers are bulk stored in outside, 5000-gallon tanks which are insulated and steam-jacketed. Chemicals are pumped underground from the tanks to the center of Bay 2 where hoses are connected to airless spray units. The present stripper was purchased from Turco. No staging or overhead guy wires are used because workers have access to all parts of the plane from power ladders. NAS has its own sewage treatment plant and waste is washed into a common floor drain, solids removed with a skimmer, and the remainder is processed as sewage. Occasional high phenol content is the only problem.

NAS Jacksonville personnel estimate that about 400 man-hours are required to mask, strip, clean, and alodize a P-3 plane at their facility.

Paint Removal At Kelly Air Force Base, Texas

Kelly AFB has special problems in aircraft stripping because of the size of the C-5. Only small area reconditioning on the C-5 is done now, but all 77 planes will be completely reconditioned in the next few years. Maintenance staging for the C-5 is elaborate, covers the entire plane, and is three tiers high along the body. The only limitation is access to the top of the fuselage which is now obtained with a lifeline harness for workers.

Jim Welch explained that a phenol-type stripper will be required for the C-5, probably because a polysulfide primer is specified. This doesn't present a problem for base disposal because the city of San Antonio is equipped to handle phenol.

Several features are unique to the Kelly operation. Prior to masking with aluminum foil, all surfaces to be taped are cleaned thoroughly with MEK. This insures a good bond and no masking ever releases during the stripping/cleaning operations.

When the stripper is to be removed, high pressure/high flow water is used in preference to "squeegee and wash". Water is applied through a beam gun at 200 psi at a flow rate of 7 to 8 gal/min. This undercuts the paint and assists in removal. Kelly personnel feel that this is highly efficient and are pleased with this innovation.

In preference to industrial "solvent cleaners" commonly used as the last stripping step, Kelly uses MEK and Scotch Brite pads. They are more than satisfied with the thoroughness of this final step.

There are only estimates as to material and manpower requirements for stripping the C-5. Jim Welch is planning on at least 1,200 gallons of stripper and about 12,000 man-hours to completely strip and repaint. More than half of the 12,000 hours will be alloted to stripping.

This facility was constructed in 1972. It is equipped for 95 percent climate conditioning (the remaining 5 percent is of geniune concern to the painting operation). The facility has an excellent air flow system based on an air filter wall in front of a water cascade. Kelly personnel feel that the designers should have opted for either water or air instead of the hybrid system installed. As presently used, the efficiency of e system is considerably reduced if the air filters are not changed frequently.

Aircraft Paint Removal at Warner Robins Air Force Base

A visit was made to Warner Robins AFB, Warner Robins, Georgia, on October 17-18, 1977, by L. J. Nowacki, H. C. Abrams, and R. J. Dick to obtain a briefing on current depainting procedures for aircraft and radomes. Mr. Harold Scott, Productivity Enhancement Office, served a liaison with base personnel.

Key base personnel interviewed during this visit included the following:

(1) Col. S. B. Barrett, MAW, Resources Management Division Chief, and PRAM Board Member

(2) Major Ron Jannsen, PRAM Alternate Board Member

(3) Fred Gordon, MABEE, Section Chief

(4) Reggie Farmer, Surface Preparation and Paint Procedure TO responsible for Air Force (912-926-6194)

(5) Carl Craft, MABEE Technical Monitor, Industrial Engineering MABEE (aircraft corrosion control) (926-5929)

(6) Dewey Meadows, Industrial Engineer (Aircraft Paint Stripping)

(7) Ulo Vilms, PRAM Office

(8) Gene Ezell, Polymer Laboratory

(9) Bill Shepard, Production Branch Chief (radome repair)

(10) Ed Glore, Deputy Branch Chief (radome repair)

(11) M. D. Jones, Foreman (radome repair).

From discussions with these key base personnel it was learned that Warner Robins has paint/depaint responsibility for the Air Force, prepares material Tech Orders in conjunction with Wright-Patterson AFB, and performs a substantial portion of the total Air Force paint/depaint operation at Warner Robins. They recognize the need for a simple depaint operation because low labor rates restrict the labor pool to poorly skilled personnel. In general, it would be desirable to relax the chemical depaint requirements and substitute more mechanical procedures. This is desirable because EPA and OSHA requirements may become even stricter in the future.

The ultimate goal of the aircraft paint/depaint program is corrosion control, but repainting is implemented long before corrosion is apparent. In practice, paint/depaint is performed when 60 percent of the aircraft's coating is deteriorating by chalking, peeling (about every 4-6 years depending on service). The old acrylic paint may last for 2 years while the newer urethanes may have an acceptable service life of up to 6 years.

The recommended depaint procedure is

(1) Wash to remove oil, grease, surface contamination

(2) Allow to dry

(3) Mask with aluminum tape (3M-425) and remove small components for individual stripping operations.

(4) Apply stripper by spray (flowed on rather than atomized) and hold for 30 minutes

(5) Scrub with stiff, fiber-bristle brush

(6) Apply second coat of stripper and hold for 15-20 minutes

(7) Agitate with brush

(8) Squeegee all loose coating

(9) If not clean to bare metal, repeat stripping agitation, and squeegee (steps 6-8)

(10) Hose down with water (120-140 F and 80-90 psi)

(11) Wash with MIL-C-25769 alkaline cleaner

(12) Apply corrosion treatment (for etch) MIL-C-38334 (Phosphoric acid, alcohol/water) and hold for 5-10 minutes

(13) Scrub with brush and rinse with much water (140 F)

(14) Apply Alodine 1200 brightener (MIL-C-5541) while metal is still wet

(15) To paint shop.

The stripping operation is performed on the C130, C141, and F-15 by three crews totaling 68 men (35 day, 20 swing, and 13 night). A C141 is completely washed and made ready for depainting in one 8-hour shift by a crew of 20 men.

Several strippers are available:

(1) Turco 85-73 (ammoniated)

(2) Eldorado PR-3400 (methylene chloride with 5 percent ammonium hydroxide)

(3) Inland Chemical AP 599 (same as PR-3400 but with perchlorethylene and methanol, etc)

(4) Intex 8562 - methylene chloride plus about 14 percent phenol ("hottest" of four compounds).

A recent tech order had recently been issued to prohibit the use of aluminum wool except on center wing area. The stripping crew foreman claimed that this adds an extra day to the stripping operation. An acceptable replacement is needed. Also needed are scrappers which will hold an edge, particularly in removing decals. Paint is difficult to remove on the underside of wings and horizontal stabilizers and not easily accessible in wheel wells. Mechanical brushes are available but have not been well received by the work crews.

Rucker Company (west coast) attempted to introduce a complete mechanized, computerized corrosion control package several years ago but it apparently was not accepted by the industry.

Several repaint facilities were identified as good contacts for site visits on the present program. These facilities are

(1) Hayes International, Birmingham, Alabama, which strips and repaints KC135 and C130 aircraft for Tinker AFB (Contact: Milton Beasley, Paint Foreman)

(2) Aero Corporation, Lake City, Florida, which has C130 and Navy contracts (Contact: Henry May, Defense Contract Administration Service, DECAS)

(3) U.S. Navy Rework Station, Alemeda, California (Contact: Mildred Patterson)

(4) McClelland AFB, Sacramento, California, which reworks F111, F102, and F106 for Kelly AFB

(5) Lockheed; Marietta, Georgia.

These facilities must be considered competitors with Warner Robins since paint/depaint contracts are let on a competitive basis.

Two major innovations have been introduced to the C130 and C141 stripping operation at Warner Robins over the past several years. These are (1) stabilized platform cranes which provide working area access to all elevated parts of the aircraft, and (2) common wing staging which permits access to the underwing areas of C141 and C130 without modification of staging. Carl Craft, who was responsible for both of these innovations, reported a total reduction in work time of 25-30% resulting from their implementation.

The Battelle personnel would like to establish a man-hour and cost baseline for aircraft paint stripping at Warner Robins to compare with any cost and man-hour figures that are obtainable from other bases and commercial companies. It was agreed that Harold Scott would obtain whatever information is available on alloted times and costs for stripping the C130, C141, and F15 aircraft, as well as man-hours actually used in 1977 for aircraft stripping and number of each kind of aircraft actually stripped.

Paint Removal, Aircraft at Tinker Air Force Base, Oklahoma City, Oklahoma

Mr. Warren Gardner gave the briefing on aircraft paint removal at Tinker Air Force Base, and showed the facility. Paint was being stripped from a KC-135 aircraft.

The original painting of KC-135 aircraft included a Corogard primer (3M Company). Many of these aircraft have been stripped on the lower half. The top was left on, but lightly sanded and washed with soap and water before application of a new paint.

Methylene chloride mixed with other solvent, wax, etc, is used for paint removal at Tinker. The stripper also contains phenol which is undesirable. The solvent is sprayed onto the surface and allowed to remain about 3 hours to soften the paint. The surface may then be hit with another spray of solvent, or a water jet to remove the loosened paint. Scraping with brushes, a hand tool, or aluminum wool may also be necessary to remove paint from troublesome areas. Finally, the aircraft is sprayed with jets of water, detergent solution and steam for cleaning.

Spent solvent and the paint removed from the aircraft are washed into the closed sewer system. However, most of the methylene chloride has evaporated into the air so little actually enters the base sewage system. The base sewage disposal plant processes this sewage before discharge into the city sewers. They can remove up to about two barrels per day of phenols, chromates, etc.

The aircraft is sent through the reconditioning shops before it is again washed with detergent water and clean water. The aircraft is given water break tests for surface cleanliness before repainting with MIL-P-23377 epoxy primer and MIL-C-83286 polyurethane topcoat.

B-52 aircraft all have polyurethane topcoat and epoxy primer, except about 40 which have polysulfide primer. The polysulfide has proven to be an excellent primer. Warren Gardner has described performance of this primer in a recent article, "A Tough Primer", Products Finishing, March, 1977. The 40 with this primer have not been back for any repainting.

APPENDIX B

INFORMATION GATHERED BY VISITS AND TELEPHONE CONVERSATIONS WITH COMMERCIAL AIRLINE PERSONNEL

APPENDIX B

INFORMATION GATHERED BY VISITS AND TELEPHONE CONVERSATIONS WITH COMMERCIAL AIRLINE PERSONNEL

Paint Removal at United Airlines San Francisco, California

United Airlines has nine large hangars for depainting, maintenance, and repainting or aircraft.

United strips and repaints the following aircraft:

(1) Wide Body - 747 and DC10 (25% of fleet)

(2) Regular - 727, 737, and DC8 (75% of fleet).

There are about 365 aircraft in the United fleet. On the average, they are repainted once every 4 years; or 60 aircraft per year. United also does some repainting and maintenance for other airlines.

The United fleet is repainted according to need. The whole fleet is inspected at least once each year. The airplanes are rated at these inspections on a scale from 5 (excellent condition) to 1 (Definite need to repaint). Priorities are then assigned for repainting the aircraft according to the above ratings.

If the rating is one, the aircraft will be brought in for repainting even though other maintenance is not needed. Otherwise, repainting is scheduled to coincide with other maintenance. United keeps a record of paint condition, touch-up, etc, in a computer bank.

Unique features of United's paint removal and repainting is that these operations are carried out while other maintenance is in process. Since the out-of-service time means lost revenue, each aircraft is painted and serviced in as short a period as possible.

Also unique at United is the use of scaffolding surrounding the aircraft so that workers have easy access to all painted areas of the aircraft surface. Separate bays are provided for each type of aircraft with the scaffolding in each designed to fit that aircraft. The scaffolding is designed so that the sections aft of the wings can be pulled aside to allow for entrance and exit of the aircraft from the work area.

Another unique aspect of the United approach is the use of the same workers for paint removal and repainting. These workers are rated as painting mechanics and considered to be part of the United skilled labor force. Each aircraft is stripped and repainted in the same spot, using the same scaffolding. This saves the time of moving the aircraft to another location for painting, allows for maintenance to continue during painting, and allows for use of the same scaffolding, for stripping and painting.

The paint system used in the United fleet is DeSoto's polyurethane aircraft topcoat over a compatible primer. Mr. Tuoey did not know the chemical type of primer.

United uses Inland and Leeder paint strippers. They first try the phenolic-free methylene chloride type. If the paint does not come off easily, they will use phenolic-containing stripper. They have also been examining some new acid type strippers that were developed recently by the various stripper suppliers. Inland, Cee-Bee, Leeder, and Turco.

The paint stripper is sprayed over vertical stabilizer surfaces. On sections of the fuselage they flow on the stripper from a fan-shaped nozzle. This procedure is used to prevent over spray from contacting other workers in the area. As the stripper is applied, the workers immediately begin to spread it and to work it in with bristle brushes. Is is then allowed to stand for 1 to 1-1/2 hours.

They then begin to scrape off the stripper and loosened paint with a Micarta scraper. Here again there is uniqueness in the United procedure. They use a trough system to catch the runoff in 55-gallon drums. The troughs are taped to the sides of the fuselage and led into tubes which convey the runoff to the drums. The recovered material is returned to Inland for its reclaim value. This also decreases United's disposal problem.

The United representative mentioned that they have tried reusing the runoff material as a paint stripper and that it worked reasonably well. He feels that reuse of stripper is a real possibility and could cut costs of paint stripping.

Regular aircraft require 6 to 8 drums of stripper. The wide body aircraft require about 18 drums.

He mentioned that ease of stripping is quite variable for different aircraft. Sometimes the paint comes off easily with a single application of stripper. Other times a second application is needed and paint will remain after the second application.

After the stripper application, paint left on the aircraft is wiped off with Scotchbrite pads wet with methylene chloride. This material is Cee-Bee A913.

United tries to go to bare metal. However, if some of the primer remains on the aircraft, they will probably repaint over it.

Finally, the aircraft is washed down with lukewarm water. Hot water would be better but United's environmentalist does not allow its use because it causes more vaporization of the methylene chloride in the stripper than does cooler water.

The wash (along with the removed paint) is also collected by the trough system. There is about 16 drums of waste water from regular aircraft and 60 drums from wide body aircraft which must be disposed of in landfills at a cost of 30¢ per gallon. Waste disposal costs are, therefore, about $264 and $990 for the respective aircraft.

The estimated man-hours for masking, stripping, wash down, and preparation for painting is about 225 for regular aircraft and 3 times as much on wide body aircraft. Eight men mask a regular aircraft in about 8 hours (64 man-hours). Stripping, scrubbing, scraping, and other work prior to wash down requires 8 men for about 8 hours (64 hours). Edge stripping is done by about 4 men in 8 hours (32 hours). Four men clean off the residue in 8 hours (32 hours).

However, United aircraft do not have paint on wings so the removal and repaint is less than on military aircraft.

The paint strippers wear full face shields, a respirator, and gloves. They are not required to wear full rain gear.

Paint Removal at Braniff International Airlines Dallas, Texas

Braniff operates about 90 planes which include 727 and DC-8 models. They use a DeSoto or Finch paint system which consists of a wash primer coat, an intermediate primer and a polyurethane top coat. No problems with filiform corrosion were identified; the DeSoto paint system was designed specifically to combat filiform corrosion.

Braniff doubled their operations facilities (located at Love Field) when the new Dallas-Fort Worth Regional Airport opened. This leaves them in the position of having a surplus of floor space under a common roof, but no extra equipment or manpower. Paint stripping is performed in a larger hangar located in a corner of their expanded building. The hangar has a cement floor without drains. No stripping was being done during the visit and the hangar was completely empty of materials and equipment as well as aircraft.

No permanent staging is used for stripping. Portable assemblies for nose and tail are stored in the lot outside the hangar and wheeled in when needed for worker access to a plane. Scaffolding is rigged along the fuselage; overhead safety cables with lifeline hookups provide accessibility to the top of the fuselage and wings.

Braniff is unique because of its exotic paint patterns and because of the amount of area painted (the entire plane except some wing and empennage areas). As a general rule, each of their 94 planes (Boeing 727 and DC-8) are completely repainted every 4 years and "touched up" on a need basis. Braniff and United are the only two major airlines which request Boeing not to allodize before the initial painting. They feel that little corrosion protection is gained and stripping is made more difficult. However, they do feel that reduced butt joint corrosion is a definite benefit from complete painting (as opposed to the metal polishing programs recently adopted by some other major airlines).

Braniff's planes usually have had at least two paint jobs when they are stripped and sometimes three. For the second and third paint jobs the plane is lightly sanded, primed, and topcoated. Therefore, Mr. Carey says that the plane that's been painted three times has a lot of paint on it and several coats of stripper may be required. Braniff's paint stripping procedure consists of the following:

(1) Mask. Aluminum tape and Polyken duct tapes are used. Braniff is not satisfied with the Polyken tape used to hold polyethylene sheet masking because it often loosens during washing.

(2) Apply stripper (Eldorado PR-3400 methylene chloride stripper conforming to MIL-R-25134), or Turco 5351. The Turco is better for DeSoto paint and the Eldorado works best for the Finch paint. This is left standing as long as it is working (paint is wrinkling) or until the stripper begins to dry.

(3) Remove stripper with squeegee.

(4) Repeat Steps 2 and 3. A second application is routinely required and a third is occasionally required.

(5) Rinse with warm water.

(6) Remove remaining paint spots. If necessary, this is accomplished with either (1) hand cleaner/safety solvent (Eldorado AP80) and Scotchbrite pads; or (2) a 1 x 8-inch circular disc pad similar to Scotchbrite adapted to a power buffing tool. The pads are sold by Bear Manufacturing Company and are available in two grades, coarse (CSC) and medium (MSC). The wheel is extremely efficient, but caution is required to prevent damage to the substrate. When extremely adherent paint is encountered (personnel in depainting generally associate this with the presence of a polysulfide primer), "Intex 8243" solvent cleaner is used. This will attack plastic (AP80 will not) and is used as little as possible for this reason.

(7) Wash with soap solution.

(8) Agitate with scrub brushes and rinse.

(9) Remove all masking except on glass.

(10) Apply acid brightener (diluted 50/50 with water). To avoid streaking, only small areas are treated at one time. This is considered a controversial step because it is difficult to remove from rivet wells and butt joints and can accelerate corrosion. Some paint companies will not honor their warranties if acid brighteners are used.

A Type 100 Boeing 727 can be stripped in seven shifts (10-11 men per shift). Four shifts are required to remove the bulk of the paint and another three shifts for hand-cleaning. A Type 200 Boeing 727 may require an additional shift and a DC-8 still another. Paint stripper required for complete removal to clean metal on a Type 100, Type 200, and DC-8 are about 4, 5, and 6 drums, respectively.

When touch-up painting is elected in preference to complete stripping and painting, the powered disc buffer described above is used to feather all edges. This is mentioned because Braniff personnel feel that this is one of their most useful tools. They are not unduly concerned about pending EPA and OSHA constraints. The absence of floor drains in the stripping hangar is an inconvenience because the spent stripper must be collected and put in drums. Since no phenol strippers are used, the excess is washed into the airport's water treatment facility.

Paint Removal by Continental Airlines, Los Angeles, California

The paint shop foreman has complete control over Continental's airplane depainting operation. He works with engineering in terms of paint systems but he controls what strippers are used and the painting process. The personnel at Continental seemed to be high quality people who are on top of what they are doing.

The Continental representative pointed out that they have problems with Sky-draul damaging their paint. They use polyurethane and Teflon paint systems. They use a polyurethane primer under the Teflon but plan to try a two-part polysulfide primer. The Teflon coating seems to provide more durability for planes operating in Micronesia where coral and sand can damage paint. Continental's planes come in every three years for a light sanding and repainting and every six years for a complete stripping and repaint.

Continental uses Inland or Cee-Bee strippers. The Continental representative indicated that they can use an Inland 561 stripper which is a methylene chloride with phenol or an Inland 508 product which is a methylene chloride without phenol. A description of Continental's paint stripping operation follows:

(1) The planes are washed prior to stripping and especially prior to sanding. Sanding will push dirt into the paint.

(2) The stripping location is outside. The stripper is agitated on the plane surface either immediately after or a short time after being applied. The used material is squeegeed off onto the ground and a second coat of stripper is applied to tough spots.

(3) The stripper and paint is scooped up off the ground and placed in 55-gallon drums. A waste disposal company hauls it away.

(4) The plane's depainted surface is cleaned with alkali soap and is washed down with cold water.

(5) Continental has a fiberglass stripper that is a nonphenol, nonacid material but it is slow acting and takes a long time to use.

For a 727 plane, Continental expends 1160 man-hours for the total depaint/repaint cycle. Thirty percent or about 348 hours of that time is used to depaint the aircraft. The stripping foreman indicated that they use 6-8 people, 3 shifts per day for 2 days to strip an aircraft. That works out to be 288 to 304 man-hours for stripping. Continental has not stripped any 747 planes to date but plans to do so. Continental operates a total of 60 planes.

Paint Removal at Western Airlines Los Angeles, California

The following is a brief description of Western Airline's airplane depainting procedure:

- The plane is brought into the hangar and critical areas are masked. The plane is not washed before stripping.
- Stripper is applied to the tail section from work stands. Spray wands are used. The stripper used is supplied by Leeder Chemical Company. It is a methylene chloride with phenol and acid.
- The plane is moved outside to a ramp area where stripper is applied to the rest of the plane. The stripper is not agitated because the stripping foreman believes agitation slows the stripping process.* Stripper application takes about 1-1/2 hours.
- After a short break the workers remove the lifted paint with squeegees. The used stripper is collected in a holding tank tank and hauled away by a disposal company.
- A second coat of stripper is applied to areas where paint was not removed by the first application.
- The plane is washed down with 350 psi cold water.
- The plane is acid etched in preparation for painting using phosphoric and hydrofluoric acid. They brush the acid with mops to distribute it over the plane's surface, work it into the cracks and then rinse it off with high pressure cold water.

Degradation of their planes' paint by hydraulic fluid (Sky-draul) is what determines the frequency of stripping. They average about 3 years between paint strippings.

The foreman has complete control of the depainting operation at Western from selection of strippers to the determination of depainting operation details. Strippers must comply with Boeing and Douglas acceptance standards, however. Western's engineering group does not control the stripping operation.

---

* Note: Dave Rosma at Boeing agrees.

To strip a 737 plane, Western expends about 48 man-hours, 4 barrels of stripper and 1 barrel of acid. The 727's, 707's, and 720's require about 80 to 90 man-hours, 6-1/2 to 7-1/2 barrels of stripper and 1-1/2 barrels of acid. The cost of material is about $7.50 per gallon.

Paint Removal at National Airlines Miami, Florida

National Airlines operates a fleet of fifty-four airplanes, thirty-eight 727's, and sixteen DC10's. Five years ago they had outgrown their facilities and added an ultra modern addition which tripled their physical plant. This impressive building was designed to accommodate all planes including the SST. It contains many bays with elevator nose docks, a sizable second story working deck which extends directly to the nose docks, and many American Monorail Stackers with 6 x 20 ft working stages that have unlimited maneuverability. However, stripping was not considered when this new facility was constructed.

Most stripping is done outside in a remote area. In inclement weather, the planes are positioned inside the new building but as far as possible from the nose docks. Plastic sheet is placed under the plane to catch drippings and the operation is performed with portable staging and wash trucks with cherry pickers. Several years ago, the National laboratory examined most available stripping materials and concluded that several Cee-Bee products were best suited to their needs. The present stripper for landing gears is Cee-Bee R256A (contains phenol) and, for fuselage, Cee-Bee A29SCW (alkaline stripper based on methylene chloride). A military specification offset for A29SCW is A236 but National personnel consider it to be slightly slower and not as effective as A293SCW.

National is now polishing (no paint) all of the fuselage beneath the paint stripe below the windows and about half of the empennage. Every other year, each plane is sanded (not stripped) and repainted. Ideally, stripping is scheduled for each third inspection (6 years) but present schedules are running much longer (5-6 inspections). This results in paint buildup in excess of 20 mils with unknown amounts of corrosion underneath.

It requires approximately 160 man-hours to sand a plane (wipe down not included) but 6 shifts to completely strip a 727.

They do not use aluminum wool because they believe that Scotch Brite pads are better and easier to use.

It requires about four to five 55-gallon drums of stripper to strip a 727. Waste is handled easily by a new processing plant equipped with a skimmer to remove solids.

National is introducing electrostatic painting and will be using a Graco unit. Present painting procedure is to cover the bare areas uncovered by sanding with a primer. This is followed by a tie coat and then a urethane topcoat.

National also strips, reconditions, and paints their own radomes. A typical radome can be completely stripped by one man in less than 4 hours using only about 3 gallons of stripper (Cee-Bee R256A). They do not believe that the phenol stripper represents a hazard when properly used by a competent worker. There is a point where the paint "pops" free and the fiberglass underneath is not damaged. No radome has ever been damaged at National when using this product. Radome stripping is generally done outside over a plastic cloth. It is then repainted with an epoxy ("Chemglaze", Lord) in decreasing areas approaching the cone, and finally, one coat of urethane topcoat (Bostik).

National personnel do not know of, and are not considering introducing, any innovations to make stripping more efficient and economical. They are not pleased with the present system but do not feel that it will be improved upon in the near future.

Paint Removal at Eastern Airlines

Miami, Florida

Eastern Airlines has recently instituted a general program to obtain greater overall efficiency for the operation of their 240 planes (three fleets of Boeing 727, DC9, and L1011). ~~John Daiuba and Ron Reider belong to a new Operations Research section which was formed to allow engineering to interact more closely with operations.~~ They realize that painting and depainting aircraft is expensive and that painted aircraft probably require more fuel to operate than unpainted craft. As a gesture toward fuel economy, Eastern has decided to limit their painting to a single fuselage stripe. As aircraft are scheduled for repainting, they are stripped to bare metal, brightened with a self-neutralizing HF solution, rinsed with water and hand polished to bright metal. It was found that maintaining this surface was too labor-intensive and current practice is to annually rework all planes to a frosted appearance. This procedure employs a chromic acid smut remover which seals the surface and minimizes corrosion. Six men can "frost" a plane in 4 hours (as compared to 80 man-days to polish a plane to bright metal and almost as much time and labor to completely strip and repaint).

Eastern has a long-term materials contract with ABG (American Business Group) which supplies everything from office supplies to chemicals. Under this contract, Eastern is supplied a stripper (ABG 73) which is probably obtained from the Dittelback Company of Atlanta. It smells of phenol and the workers say it is very effective. The stripping operation is (1) apply chemical, (2) hold for 45 minutes, (3) squeegee-off, (4) repeat Steps 1-3, (4) hand-strip any difficult areas. ~~Only~~ Staging is used for worker-access to 727's and DC9's and only minimum masking is used. During the fuselage stripping the wings were observed being covered with only a polyethylene drop cloth and the fuselage engine inlets were not covered at all. Because of the size of the L1011, a special hangar is required and this is equipped with (1) elaborate staging, (2) scissors man lifts with small baskets, and (3) Tram Rail Platforms (approximately 6 x 10-foot working area). Eastern is not pleased with cherry pickers because it is too easy to damage a plane by impact, scraping, etc.

Paint Removal at Eastern Airlines Miami, Florida

Eastern Airlines has recently instituted a general program to obtain greater overall efficiency for the operation of their 240 planes (three fleets of Boeing 727, DC9, and L1011). They realize that painting and depainting aircraft is expensive and that painted aircraft probably require more fuel to operate than unpainted craft. A a gesture toward fuel economcy, Eastern has decided to limit their painting to a single fuselage stripe. As aircraft are scheduled for repainting, they are stripped to bare metal, brightened with a self-neutralizing HF solution, rinsed with water and hand polished to bright metal. It was found that maintaining this surface was too labor-intensive and current practice is to annually rework all planes to a frosted appearance. This procedure employs a chromic acid smut remover which seals the surface and minimizes corrosion. Six men can "frost" a plane in 4 hours (as compared to 80 man-days to polish a plane to bright metal and almost as much time and labor to completely strip and repaint).

Eastern has a long-term materials contract with ABG (American Business Group) which supplies everything from office supplies to chemicals. Under this contract, Eastern is supplied a stripper (ABG 73) which is probably obtained from the Dittelback Company of Atlanta. It smells of phenol and the workers say it is very effective. The stripping operation is (1) apply chemical, (2) hold for 45 minutes, (3) squeegee-off, (4) repeat Steps 1-3, (4) hand-strip any difficult areas. Staging is used for worker-access to 727's and DC9's and only minimum masking is used. During the fuselage stripping the wings were observed being covered with only a polyethylene drop cloth and the fuselage engine inlets were not covered at all. Because of the size of the L1011, a special hangar is required and this is equipped with (1) elaborate staging, (2) scissors man lifts with small baskets, and (3) Tram Rail Platforms (approximately 6 x 10-foot working area). Eastern is not pleased with cherry pickers because it is too easy to damage a plane by impact, scraping, etc.

Stripping materials are handled in drum racks as opposed to bulk storage and a "rack" contains three 55-gallon drums of stripper and one of water for rinsing. It requires about 4-5 barrels to strip a DC9 and about 6-7 for a 727.

Eastern also strips and does minor radome repair. Generally, only the "boot" or nose of the radome is stripped and this requires about 3-4 gallons. A methylene chloride stripper from ABG is used and this requires close attention to prevent damage to the substrate. Radome and small part stripping is done in an open area over a grate with a strong down draft into a water tank. Very little odor was discernible.

Eastern is aggressively pursuing several nonchemical approaches to aircraft stripping (200 of the 240 planes are still completely painted). He is interested in developing a mobile, industrial paint-stripping machine which might be based on ultrasonic or possibly as a pulsating pressure (0-2000 psi) cleaner. Ron has been in contact with companies such as Blackstone and Westinghouse to develop this type of equipment.

Another piece of equipment he is designing is a pneumatic power brush with a nylon pad. A prototype of this design has a 6 x 12-inch barrel base for the nylon pad.

Eastern's efficiency program is concerned with every detail of their operation. They have been examining a wash rack problem of plexiglass window scratching (approximately $100,000 per year window replacement costs). Mops were turning over and the workers were scratching the windows with the bolts on the back of the mop. Simple problem solving such as this is a large part of the Eastern efficiency program.

Paint Removal By
Delta Airlines
Atlanta, Georgia

Delta's paint system consists of a wash primer coat, a chromate-rich intermediate coat and a polyurethane topcoat. Delta uses an Intex 8573 methylene chloride nonphenol stripper as their primary stripper. On planes that are difficult to strip, they will use a Turco 5351 methylene chloride, phenol stripper.

The airplane is masked by the painters before it is turned over to the cleaning crew for stripping. Seven people are normally used to mask and 7-10 hours is usually required to complete the job. No masking is done on the wings of the aircraft because Delta strips only the fuselage and tail. In addition, the fuselage surface below wing level (slightly below the horizontal centerline) is not painted. Delta uses polyethylene paper held in place by a black polyethylene tape. A 3M #226 aluminum-backed tape is used to cover the black polyethylene tape. Areas around doors and windows are not painted so the surface on which the masking material adheres does not have to be spot stripped before or after the main stripping job.

Delta operates DC8, DC9, L1011, and Boeing 727 planes. On a typical 727 plane it takes 4-6 men about 16 hours to strip the paint. The plane is not washed prior to stripping. The stripper is applied to the plane using Graco barrel pumps and wand sprayers. The stripper is not atomized as it is applied but is actually flowed on or applied as a thick spray. The stripping crew works from the tail toward the nose of the plane applying stripper to a section at a time. The stripper is usually allowed to work about 30 minutes before any agitation is done. After the dwell time has passed, the stripper is squeegeed off onto a polyethylene sheet that covers the floor. Subsequent coats of stripper are then applied. No feathering of hard-to-remove paint spots is allowed so all the paint must be removed.

After the plane is completely stripped and all the stripper has been squeegeed to the floor, the plane is wiped down with a B-1000 light solvent. The spent stripper is picked up off the polyethylene sheet and disposed of in a dumpster. Ultimate disposal is in a landfill.

Water is not used to wash down the plane until after the plane is completely stripped. The plane is washed after the stripper is removed and it is wiped clean with solvent. Delta is very careful not to let any stripper get

into their drain system because their sewage treatment plant is not capable of handling it. They have an effluent limit of 15 PPB of phenols. Ajax cleaner and a mild acid etch are used as the final preparation for painting.

Delta averages about 4-6 barrels of nonphenol stripper per plane if the plane is painted with the wash primer system. A plane that has an epoxy base coat requires 10-12 barrels of stripper. A plane painted with epoxy might take up to four 3-shift days to strip. As indicated previously, they have to remove all paint before the plane goes to the painters.

Delta has extensive, permanently-installed tail staging which has the capability of raised and lowered work levels. In addition, an overhead-supported structure with x-y-z movement capability is used to provide access to fuselage surfaces.

Workers are supplied with rain gear for protection when working with the stripper. They have not had problems with fumes from the stripper but are concerned with future OSHA regulations.

Delta's stripping operation is much the same as those of other paint stripping facilities that have been visited. They seem to be greatly concerned about prevention of any stripper going down the drain because of potential water pollution problems.

When the Warner Robins paint stripping operation was described to the Delta representative he said he thought Warner Robins was doing real well and pointed out that the wings and the area under the fuselage are the most difficult to strip on an airplane. At Warner Robins, 10 men (2 at nose, 4 in baskets, 4 on tail) on the day shift are used to strip approximately the same areas on a plane that Delta covers with 6 men. Elapsed time at Delta is 16 hours. Elapsed time at Warner Robins was two shifts (16 hours) on the plane the BCL personnel observed being stripped. It should be pointed out that the Delta stripping crew does not have to mask the plane and that the Air Force paint system is probably generally more difficult to remove than Delta's.

Paint Removal by Trans World Airlines (TWA), Kansas City, Missouri

TWA operates 228 planes consisting of 747, L1011, 727, and DC9 models. They have not gotten into routine stripping of the wide-body models because those planes are fairly new.

TWA has a special deck for stripping and washing aircraft. Their operation is basically very similar to that observed at other facilities. The procedure is as follows:

(1) The plane is brought into the stripping hangar on the graveyard shift and is masked. Masking consists of protecting windows, vulnerable fiberglass areas, etc. Polyethylene tape is used to cover seams and to hold down aluminum backed sheet material that covers areas that must be protected. Six to eight people are used to do the masking which is completed by 7:00 a.m. so the day shift can strip the plane.

(2) TWA uses Cee-Bee A29 SCW stripper which is a methylene chloride nonphenol type. Their paint system includes a wash primer base coat. They have experienced difficulty when stripping an occasional plane that has an epoxy primer base coat. If the problem is severe, an acid stripper is used as a last resort.

The stripper is applied using barrel pumps and spray wands. Access to the plane is provided by four-tracked vehicles that have articulated booms with personnel baskets mounted on the end. The vehicle tracks are arranged so two units move along the leading edge of the wings and parallel to the forward fuselage. The other two units move parallel to the aft fuselage up to the wings. The booms reportedly provide the capability for the worker to reach all surfaces of the aircraft. Water service is supplied up to the boom to the personnel basket.

(3) After the first coat of stripper works for a half hour or so, it is squeegeed and the plane is rinsed down. A second coat of stripper is then applied. Scraping of tough spots is minimal.

(4) The wash down is done using 600 psi wash nozzles.

(5) After washing the plane is etched in preparation for painting.

(6) Paint that can't be removed from the plane by two stripper applications is buffed by hand with Scotchbrite pads in order to feather the paint edges.

The stripping process usually starts around 7:00 a.m. and is completed by noon. Six to eight people are involved. It should be noted that TWA does not strip wings or the belly of the plane because those surfaces are bare.

Used stripper and paint is scooped up and disposed of in a landfill. Residue is washed down the drain to the TWA waste treatment plant.

On the bulk of their fleet TWA strips every time a plane is repainted. However, this may change for some of their planes in the future. Epoxy primers exist on those planes and sanding is being considered because the epoxy primer provides an extremely strong bond to the aluminum skin.

Paint Removal by Pan American New York, New York

Pan Am runs 707, 727, 747, and 747S planes. Their paint system includes a wash primer coat, an intermediate coat and a polyurethane topcoat. Pan Am has problems with filliform corrosion but continues to use wash primer. They make certain to alodine treat corroded areas after stripping and before painting.

Pan Am has closed down their Miami overhaul base and is in the process of moving things to New York. They have not stripped planes at New York yet. Consequently, the information obtained was sketchy.

Pan Am uses B and B, Turco, and Nuvite (Nuvite Chemical Compounds; Brooklyn, New York) strippers. It is not known if they are nonphenol, phenol, or acid strippers. The stripper is sprayed on using wands and Graco barrel pumps. It's washed off with cold water. In the past it has taken an average of 5 days, 2 shifts per day to mask and strip a plane (the staffing per shift was not specified). Stripping time varies substantially from plane to plane and for different weather conditions. Workers are provided access to the planes by scaffolding.

A visit to Pan Am would serve no useful purpose because they, at New York, haven't stripped planes and the Miami base is closed.

Paint Removal by North Central Airlines Minneapolis, Minnesota

North Central runs twenty-eight DC9 and twenty-six Convair 550 planes. They use U. S. Paint Co. (St. Louis, Missouri, (314-621-0525) paints on their planes. The system includes a wash primer coat, an intermediate corrosion inhibiting coat, and a polyurethane topcoat. North Central had filiform corrosion problems but that has been eliminated by modification of the paint composition by U. S. Paint Co.

North Central uses a Cee-Bee 292 paint stripper. The information source was not sure if it was nonphenol or phenol. They've been using that stripper for 12-14 years which is evidence of their satisfaction with it. Graco barrel pumps and spraying wands are used to apply the stripper. The stripper is allowed a dwell time of 20 to 30 minutes before it is scraped off with micarta scrapers, after which a second coat is applied. Warm water is used for final rinse. 3M Scotch Brite pads are used on the fuselage surface and seams are blown to remove paint particles. A Cee-Bee 350 cleaner (reported to perform similar to MEK but nonexplosive) is then used to clean the surface. Finally, a Cee-Bee 55 etch is used prior to painting. Spent stripper is picked up and put in a dumpster and hauled away to a landfill

About 18 hours were estimated for masking and stripping a plane. About 12 men are employed per shift (unsure of the exact number). Workers, classified as cleaners, do the stripping while mechanics do the masking and painting. Mechanics also do the final etch in preparation for painting. It was not known how much material was used to strip and etch a plane.

North Central does all their work indoors because of weather conditions. Movable scaffolding is used for the DC9 planes and fixed scaffolding is used for the Convairs to provide worker access to the plane's surfaces. Workers are provided full rain gear, face masks, and respirators for protection.

Paint Removal at Flying Tiger Airlines
Los Angeles, California

Flying Tiger's stripping process is much the same as for other airlines that have been contacted, but not as extensive because the paint design consists of a painted tail and a decorative stripe down the fuselage.

Flying Tiger's stripping procedure is as follows:

(1) The first step is to mask planes. Windows, fiberglass, and hinge joints are masked. Running gear is protected.

(2) The plane is stripped using barrel pumps and a wand sprayer. A fine spray is applied. The first coat of stripper is worked around with hand brushes, squeegeed off and a second coat is applied.

(3) The plane is washed down using high-pressure water.

(4) They demask the plane, hand strip masked areas, and sand down fiberglass areas.

They usually run a DC-8 through the stripping operation in one day with 4 men for three shifts. He did say that they expect to strip a fully painted DC-8 from Air Siam and anticipate spending 130 man-hours on it.

Waste goes into a holding tank and is hauled away by a disposal company.

Personnel protection is typical full-cover gear with face masks but no auxiliary breathing air is used.

Flying Tiger uses the following products:

Item	Description
Turco B19	Alkaline Stripper
Cee Bee A292	Alkaline Stripper
Cee Bee A202	Limited Use Acid Stripper
Calla 500	Degreaser applied before stripper
Calla A301	Degreaser applied before stripper
Turco B55	Brightener applied to plane after stripper and prior to paint

Paint Removal at Frontier Airlines
Denver, Colorado

The Frontier representative described the paint stripping process for a Boeing 737 as follows:

(1) They mask fiberglass areas, windows, randomes, and running gear areas. This takes 5 men about 8 hours.

(2) The stripping process follows. This takes 6-8 people 10 hours. They combine two strippers, one is brown, the other yellow; one thick, the other thin. The Frontier representative thought the number was 1717, manufactured by B and B Chemicals in Florida. They apply the stripper with wand sprayers, leave it on the plane 1 hour and work it around with mapheads to loosen the paint. They re-apply scripper to areas that are still tight. To remove all paint may take 2 or 3 applications to some local areas.

(3) After all paint is loosened they spray down the plane with firehoses. They don't wash down until all paint is loosened because water neutralizes the stripper. The waste material is washed down the sewer and has not been a problem environmentally.

Other stripper companies mentioned were Cee Bee Chemical and Magnus Chemical. Frontier plans to try a stripper from Cee Bee that reportedly is good. They also plan to try a tank pump manufactured by Graco. It aerates the stripper and applies it as a foam to decrease run-off.

The only tools they use to help loosen the paint are mops, bristle brushes, and squeegees all on long handles.

The workers are given protective clothing including gloves, boots, and face masks. Breathing air is not supplied. Fumes are not a serious problem. They suggest coating face and hands with vaseline.

The wash primer is often not removed by the stripping process. Workers wipe it off with rags soaked in MEK.

They do not strip fiberglass areas but instead sand and repaint. They also repaint an entire plane 3 to 4 times between strippings. These repaint jobs are preceded by light sanding.

The representative suggested that I contact World Airlines. They have a California contractor do their planes who reportedly does an excellent job. That contractor has done Frontier planes in the past. They also contract to the Air Force. He also suggested United Airlines. He said they strip very efficiently and actually do other maintenance while they strip. They also catch the used stripper and have looked at recycling it.

Paint Removal at World Airways Inc.
Oakland, California

The Oakland representative indicated that World Airways does depaint some of their planes at their facility and they do some contract work for other airlines. However, they contract most of the work to United Aircraft Service, which sends men to the World Airways facility to do the work. He suggested I talk to a representative of United Aircraft Services.

APPENDIX C

INFORMATION GATHERED BY VISITS AND TELEPHONE CONVERSATIONS WITH AIRCRAFT MANUFACTURERS PERSONNEL

APPENDIX C

INFORMATION GATHERED BY VISITS AND TELEPHONE CONVERSATIONS WITH AIRCRAFT MANUFACTURERS PERSONNEL

Paint Removal at Boeing Aircraft Company, Everett, Washington

Boeing strips the fuselage on 747 aircraft only. The stripping materials used relate to the paint system on the aircraft. The Boeing paint system is a polyurethane outer coat made by DeSoto over an amine-cured epoxy primer. The amine-cured epoxy primer is harder to strip than the polyamide-epoxy primer used by the Air Force and because of this, the stripper used must contain phenol. Therefore, Boeing uses a Turco 5351 methylene chloride phenol stripper. They had plans to try an Inland AP-561 acid stripper which is the same that is used by United Aircraft Services (see report of procedures used by United Aircraft Service). The concern with acid strippers is that it will remove the cadmium plate and will hydrogen embrittle the high-strength steel fasteners used in various places on the aircraft.

Boeing personnel believe that the stripper should be applied as an evenly flowed-On coat from an airless gun. They have observed that the material which is brushed on does not get the protection from the waxes that the flow-on method provides. If the wax protection is decreased the solvent evaporates readily and the effectiveness of the stripper is diminished. By flowing on an even, heavy coat on the entire aircraft the waxes can float out to an even coat and protect the solvents. This reasoning also supports the argument for allowing the material to work for an hour to an hour and a half before agitating it so the wax barrier is not broken.

It appears that the actual stripping operation from the time the airplane is ready for stripping after masking until the stripper has been removed from the aircraft by rinsing, or squeegeeing and rinsing is probably the smallest part of the staff time requirement. On the 747 an average time for masking will be 16 men for 8 to 12 hours. If an average of 10 hours is used, that would be 160 hours for masking the aircraft prior to stripping.

The actual stripping time consisting of the application of one coat of stripper and the staff time to remove it is 8 to 16 men for 1 hour. If one uses the maximum of 16 men for the hour, that's 16 hours, and if two stripper applications are required to depaint the airplane, that's 32 hours. If they all then go back with hand touchup for another hour, this amounts to a total of 48 hours compared to 160 hours masking the plane. Even if the 1-1/2-hour time is added for the men to wait while the stripper works, the time does not approach that of masking at Boeing. In fact, the men don't sit around for 1-1/2 hours waiting for the material to work; they do other things. However, if they do wait around, it has been suggested that they have earned this time.

Boeing has the same labor utilization philosophy that United Airlines has. That is, they view stripping as part of the preparation for painting and the stripping operation is done by the painters. In this way, they give the painters more responsibility. The painters are totally responsible for preparing and painting the airplane. They, therefore, do not use the low-quality workers found in other places including the military. This seems to be a very effective management utilization of labor.

Facility

Boeing has one hangar at Everett which is used for depainting, maintenance, and painting of aircraft. It is an elaborate facility, well designed for the activity. There are permanent wing stands for access to the under wing surfaces. The rest of the airplane access is by stacker cranes similar to those found in large warehouses which move from the floor to the ceiling and can move in the XY direction over the floor. They are actually suspended on columns from the crane at the ceiling. Each stacker has room for two men, carries all services such as electricity, water, air, steam, and lights as required. The stripper is carried on the stacker in 55-gallon drums and dispensed by a Grayco airless pump. There are four stackers on each side of the fuselage, two forward of the wing covering the nose area, two after the wing covering the fuselage area, and one with an extra long

configuration to cover the width of the tail (for a total of five stackers on each side of the aircraft, or ten stackers total). These stackers are manned by 8 to 16 men as required. The stackers, of course, can also travel over the top of the wing.

The wings are painted for corrosion protection only and are not ordinarily stripped for appearance repainting. For the upper surface of the wing a 50:50 mix of MEK and toluene is used to remove the Corroguard. The bottom of the wing is stripped in the same manner as the rest of the airplane.

Downdraft air is supplied from the plenums in the ceiling so that free fumes in the atmosphere are at a minimum. Even so, men are required to wear protective clothing and full face and head masks with respirators when working with the solvents or stripper materials.

The stripper material is applied to the airplane, allowed to work, and then brushed and squeegeed to the floor. Under the floor of the building is a series of ditches in which 150,000 gallons of water is ordinarily circulated to pick up dust and solvent from the painting operations. However, during the stripping operation, the canals are dammed off and drained, and then the stripping waste (which includes stripper, paint, and rinse water) is rinsed into the canal or ditch. Waste material is pumped out of the ditch into a tanker truck and removed for reclamation and disposal.

It is interesting to note that Boeing is responsible for the disposition of the material even though it has been turned over to a contractor until its final approved disposition. This requirement has been placed upon Boeing during the past year by the local environmental protection agency.

The Boeing representative was familiar with United Airline's facility, which had impressed us so very much. He believed that the stacker crane approach that Boeing uses is much more efficient than the permanent dock system used by United Airlines even though the men on the stacker have to take time to move it to a new position. Apparently, he feels that the increased efficiency is due to better access to the surface of the aircraft if less parts of the stacker are in their way. It would appear that the men on the United Airlines dock would spend the majority of their time stripping and cleaning airplanes while the men on the stackers have to spend a portion of the time of moving the stacker. The times quoted, however, seem to support the contention of the Boeing representative because the 747 airplane is bigger than many of the airplanes stripped by United Airlines.

It is impossible to obtain realistic stripping time numbers from Boeing (or for that matter, the other information sources). The times are not recorded in the right fashion and the numbers vary widely according to the airplane and its paint system and the condition of the paint. In addition, there is the problem of comparing different size and complexity of airplanes.

The facilities at Boeing are quite extensive. It seems that the idea of only moving the airplane once into a "depaint-maintain-and-paint" hangar makes sense. Men can be moved around easier than the aircraft, and some maintenance operations go on during most of the stripping and even some of the painting operations.

New Approaches

Two different approaches to depainting airplanes were discussed, and one relating to depainting radomes. One was the idea of CO_2 pellet abrasive blasting of aircraft to remove the paint. The Boeing representative said this was an old idea that had been around awhile. Boeing has tried it and found that it is not cost effective. The danger of abrading or peening the surface of the aluminum is too great for them to consider using it. To that must be added the problem of a CO_2 enriched atmosphere or a means of conducting the CO_2 away, the very high cost of compressing air to operate many abrasive blasting guns, and the cost of the labor to operate the guns when each one could only remove a few square inches at a time. He did not consider it a serious contender. He was the second knowlegeable person who has had some familiarity with the CO_2 pellet abrasive blasting idea and has discarded it as being impractical.

The second ideas discussed was water-jet abrasive stripping of aircraft. This method imparts danger to personnel, as well as danger of damaging the aluminum surface. Moreover, it is difficult to apply water jets to the aircraft. The Boeing representative acknowledges the difficulties with water-jet blasting. Boeing has done some minor testing with it but have made no equipment. Nevertheless, they are looking into it seriously with a couple of new ideas. They feel the jet can be fixtured so that its position is automated in its relationship to the aircraft's surface. That is, a fixture will move the jet over the aircraft surface, adjusting its angle to be tangent to the surface at that point. The fixture will move the jet in a motion which is

most effective in relation to the plane's surface, either circumferentially or longitudinally. Thus, the objections raised as to the danger to the aircraft and to the personnel would be overcome by taking the jet out of the hands of the personnel. The second idea would be a method of catching the overspray and returning it for recycling.

Regarding radome stripping, Dave suggested that a solvent-sensitive primer could be developed for radomes which would allow them to be stripped with a hot solvent. He suggested that a primer sensitive to trichloroethylene could be developed which would permit the radome to be suspended in a degreaser. The hot solvent would penetrate the paint, soften the primer, and remove the paint coat conveniently.

Paint Removal at Lockheed-Georgia
Marietta, Georgia

Lockheed-Georgia, a division of Lockheed Aircraft Corporation, is located on Dobbins Air Force Base, Marietta, Georgia. They are engaged primarily in aircraft production so that much painting but no significant amount of stripping and repainting is done here. However, if the C141 stretch program is funded as planned, 200 planes will require stripping and repainting, primarily in Marietta.

The Lockheed representative reported that Lockheed-Georgia has always specified an aircraft paint system of wash primer, epoxy undercoat, and urethane topcoat. This is ideal for stripping since the wash primer is the "weak link" of the system which allows the use of mild methylene chloride strippers. They have been using MIL-R-25134 materials such as Turco 1E and 1D. No acid or phenol materials are used. However, this summer they had serious adhesion problems with the wash primer on hot muggy days and the decision has been made to use an upgraded system of conversion coating, epoxy primer, and a urethane topcoat. The C141 stretch planes may also get a Products Research PR-1432GP polysulfide primer. With these new systems, Lockheed-Georgia will use a T.O. 1-1-8 material such as Turco's nonembrittling stripper with chromate but without phenol. They will continue to use commercial materials of their choice. No Air Force MIL-SPEC materials exist (as compared to Navy materials). They will not order anything from GSA because of GSA providing only minimum specification materials.

The present stripping operation consists of the following:

(1) Clean to obtain good adherence for masking, and grease-free surface for best stripper action.

(2) Mask and seal edges with aluminum foil tape (also apply tape to all joints and seams for protection to such items as wing tanks).

(3) Apply stripper and allow to work for about 20 minutes.

(4) Agitate with plastic scrapers (may use Scotchbrite pads and MEK for difficult areas).
Note: No water is used until the entire paint area to be removed is loosened to bare metal.

(5) Rinse with tap water. Lockheed has an industrial three-stage drainage system that allows all material to be washed into the drain.

(6) Alkaline clean and metal condition plane prior to painting.

Lockheed-Georgia has many areas (both indoors and outdoors) where stripping is done. Therefore, most materials are handled in 55-gallon drums (the main facilities have 300-gallon liquid bins). Outdoors, access to the plane is obtained from wing stands and cherry pickers. Indoors, facilities include portable wing stands, tail staging, and roving stands somewhat similar to those used at Warner Robins.

Lockheed-Georgia apparently has no problems motivating their wash rack crews. Workers have a strong union which guarantees acceptable job descriptions and wages.

The plant was on strike during my visit and I did not see a plane being stripped. No "man-hours per unit operation" data are available.

Lockheed California Company
Experience with Dry Ice Blasting
Burbank, California

Mr. Fong has been a proponent of CO_2 blasting. However, he indicated that abrasive blasting with dry ice is no panacea for the airlines. Although cleanup costs are reduced and the used stripper disposal problem is eliminated, there are disadvantages. The dry ice blasting method is expected to be substantially more labor intensive than a method which utilizes a chemical stripper. Mr. Fong estimates that the cost of blasting using dry ice may be from 10 to as much as 100 times the cost of sandblasting. Because of the high cost, its applications may be limited to special areas. He believes cleaning of jet engine blades in place may be a possibility because dismantling the engine prior to cleaning with dry ice may not be required.

Lockheed has in the past attempted to work with Airco and Clemco Clematina Ltd. to develop equipment for dry ice blasting. Both companies have backed out of their agreement with Lockheed, probably because of the process being too expensive. Presently, Lockheed has an agreement with Chematronics of Ann Arbor, Michigan, whereby each company is licensing patent rights from each other which complements their own efforts in forming an overall system.

As a result of his promotion of the dry ice blasting concept, Mr. Fong reportedly has received many inquiries from airlines and the nuclear power industry. However, his system seems to be but slightly advanced beyond the basic laboratory stage. He has not been able to extensively investigate the effects of ice pellet size, air flow, and the numerous other factors that may be important. Laboratory results are not available to support many of the claims regarding the capability of the process.

Lockheed management has not placed high priority on development of the dry ice blasting concept. Funding for correction of fundamental problems appears to be at a low level.

Summarizing, the dry ice blasting method of removing paint works and eliminates a waste disposal problem. However, the process is anticipated to be very slow, time-consuming, and expensive.

Paint Removal at McDonnell Douglas
St. Louis, Missouri

A representative of McDonnell Douglas' Equipment Engineering Department indicated that McDonnell Douglas is not involved in stripping paint from assembled aircraft. They strip small parts and do some primer stripping on assembled aircraft before they go to the paint shop. He knew of no new paint removal techniques that are being developed.

A visit to McDonnell Douglas was not made because they are not actively involved in removing paint from assembled aircraft.

APPENDIX D

INFORMATION GATHERED BY VISITS AND TELEPHONE CONVERSATIONS WITH PERSONNEL OF COMPANIES WHO STRIP AIRCRAFT ON A CONTRACT BASIS

APPENDIX D

INFORMATION GATHERED BY VISITS AND TELEPHONE CONVERSATIONS WITH PERSONNEL OF COMPANIES WHO STRIP AIRCRAFT ON A CONTRACT BASIS

Paint Removal by Hayes International Corporation Birmingham, Alabama

Hayes International Corporation of Birmingham, Alabama, is a subsidiary of City Investing Company, New York. Hayes employs over 2000 people in maintenance and rehabilitation of aircraft; for example, C130 subcontracts from Warner Robins and KC135 subcontracts from Oklahoma City.

Last year Hayes depainted about 150 - 135's and 65 - 130's. However, only about 25% of the 135's get completely stripped and repainted (average area stripped is about 30%), and only about 40% of the 130's get completely stripped and repainted. Hayes maintains both outdoor and indoor facilities for stripping in summer and winter, respectively. Both facilities consist primarily of overhead guy wires for attaching safety harnesses and minor staging for C130 tail assemblies. Some 130 tails and all 135 tails are routinely removed for maintenance and are stripped at this time.

Hayes uses all B & B chemical materials on a contract basis. Their two strippers are: "1776" (all purpose) and "1567A" (for epoxy and urethane). Neither contain phenol. These are handled through bulk storage tanks (both 3000 and 6000-gallon tanks for each) and the material is piped to the work site.

The complete stripping operation consists of five steps:

(1) Mask
(2) Spray stripper
(3) Agitate with aluminum brush
(4) Steam-clean (about 150 F at 100 psi) -- repeat Steps 2-4 until acceptable
(5) Wash all stripped areas with alkaline cleaner.

Note: Planes are never washed before stripping.

Ten men are employed per shift and it requires three to four shifts to completely mask, strip, clean, and alodize a KC135. This time dos not vary with the percentage of area stripped because it requires more masking

time for less stripping. The three to four shift time does include special attention to unusual items such as wheel skis used on C130's in Alaska (ski-birds).

Housekeeping is excellent. All liquid material is washed into a floor drain, brought to a common sump and filtered before entering the plant's control water treatment system. The filter requires cleaning every 3 to 4 weeks. At present, the processed water is dumped into the city sewage, but a water recycling loop is being considered.

The Hayes representative indicated that their system is efficient and he knows of no areas which need major improving. The labor union lists his workers as "cleaners" and they are highly motivated, largely through his personal efforts. Pay is "satisfactory" for a Class "B" cleaner ($5.18/hr - does only stripping-related operations) and "good" for a Class "A" cleaner ($5.68/hr - also does some minor repair operations).

An entire old building is used for "bead blasting" or aircraft tanks holding demineralized water carried for extra lift-off for some planes. The tanks are coated with a urethane which, in time, flakes off and allows corrosion to proceed. "Bead blasting" is difficult and cumbersome, and Hayes might be interested in other techniques if available.

Paint Removal by Aero Corporation Lake City, Florida

Aero Corporation, Lake City, Florida, is a small, private company engaged in aircraft repainting and some maintenance.

Aero has both Air Force and Navy painting subcontracts and handles them quite differently. Under Navy contract, Aero is free to select specification strippers and paints from the vendor of their choice. Under Air Force contract, Aero must use GSA materials which (they feel) meet only minimum specification requirements and are not the most economical from a performance-labor standpoint. Aero is presently required to use "Intex 8562" paint stripper, but would rather use a stronger stripper. Another basic difference is environment. Navy contracts impose no limitations and stripping is done outside where the sun will warm the aluminum. Air Force specifies indoor stripping which requires a large, cold and damp shed which (Aero personnel feel) is less than desirable.

The stripping operation consists of the following:

(1) Wash plane to remove dirt, oil, and grease.

(2) Apply stripper and hold for 15 to 30 minutes according to temperature, etc.

Note: Workers are on stands, not permanent staging, and no overhead wires are used.

(3) Agitate with nylon brush (aluminum is forbidden by Tech Order).

(4) Cold water wash (400 psi) to remove stripper.

(5) Repeat Steps 2-4 until acceptable depainting is obtained. An average of three cycles is required and some jobs need up to ten.

(6) Thoroughly wash before metal preparation and alodizing.

It requires about 500 man-hours to strip a 130, but this can run as high as 1100 to 1200 hours if wheel wells are included, if it is a skibird, or other unusual circumstances prevail. The 500 hours usually means about 5 days/2 shifts. Material requirements for stripping a 130 is about 21 - 55-gallon drums.

Aero is required to have their own sewage system because they are located outside of the Lake City service area. Solids are collected and the water is cleared by spraying into the air. It is not recycled for further use.

Paint Removal at United Aircraft Services Rialto, California

United Aircraft Services is a contractor that depaints aircraft for the airlines and the military. Mr. Ben Warren, President of UAS, said that they stripped 60 planes last year and claimed that his company strips more aircraft than any other organization in the U.S. They've stripped primarily 747, TC8, 707 and 727 aircraft and at one time partially stripped a C5. They have also stripped 60 C141's under the wing area and two DC9's for Lockheed at Long Beach. Mr. Warren assembles an eight-man crew at the customer's selected location whenever a stripping job is scheduled. UAS has cherry pickers located at five locations on the West Coast so the customer can bring the plane to the UAS equipment or Mr. Warren will use equipment supplied by the customer.

United Aircraft Services' typical aircraft depainting procedure is described below:

- The plane's surface is not prewashed before stripper is applied.
- The plane is masked with aluminum stripper paper which is held in place with Borden Mylar 7300 tape. An aluminum tape is in turn placed over the Mylar tape to protect it from stripper. Mr. Warren pointed out that a good masking job is important to the success of his stripping operation.
- United Services uses Inland AP561A stripper, an acid phenol methylene chloride material that Mr. Warren feels rinses better than competitive strippers. A Graco 10-1 barrel pump supplies the stripper to a hand-held spray gun that is fitted with a 8006 tip that provides an 80-degree fan and delivers 6 gpm. The crew usually uses only one spray wand and pump to apply stripper but occasionally will use two. The stripper is applied sparingly so it doesn't run off the aircraft and about 1-1/2 barrels of stripper are reputed to be used per plane.
- They do very little agitation and it is usually only done where decals are located.
- After the stripper has had time to work, it is rinsed off with cold water and additional stripper is immediately reapplied. Mr. Warren denied that water inhibits the stripper action and said that water affects the stripper very little. The plane is rinsed again after

the second stripper application has had time to work. Waste material is put into 55-gallon drums and disposal is the responsibility of the customer.

- A CeeBee B55 acid etch material is then applied with a sprayer and horsehair brush to the plane's surface. The etching material is primarily a phosphoric acid with a small amount of hydrofluoric acid in it and is similar to the Leeder Chemicals etching material used by Western Airlines. The acid cleaner material is then rinsed off and the plane is demasked to complete the depainting process. Warren indicated that they use about 10 gallons of etching material per plane.

Mr. Warren said he works his eight-man crew on a 24-hour straight-through shift when they are stripping a plane. Therefore, his crew expends 192 man-hours to mask, strip, etch, and demask an airplane. He gets about $7000 for stripping one plane and pays his men $400 each for a 24-hour shift. Western Airlines claimed about 90 man-hours per plane for the same job. Mr. Warren indicated that his material cost is $5.51 per gallon but the $7.00 per gallon is a fair price. It should be noted that the material usage rates claimed by UAS are extremely low compared to other organizations.

Regarding safety, UAS does not provide elaborate protective gear to the stripping crew. Warren does not use goggles and believes that light cotton clothing is best. He reasons that if one gets stripper under the protective clothing, he can't remove the protective gear fast enough to wash the stripper off before it has done severe damage to the skin. A person wearing cotton clothing can be hosed off immediately. Mr. Warren said they use a stripper application hose that costs $2.00 per foot and they only use the hose three or four times before discarding it in order to reduce the chance of hose breaks.

APPENDIX E

INFORMATION OBTAINED FROM COMPANIES
WHO SUPPLY CHEMICAL STRIPPERS

APPENDIX E

INFORMATION OBTAINED FROM COMPANIES
WHO SUPPLY CHEMICAL STRIPPERS

Eldorado Chemical Inc
San Antonio, Texas

The following chemicals are supplied by Eldorado for aircraft paint removal:

PR-3200 - methylene chloride type with no phenolic. Low-priced stripper containing appreciable alcohol. Not recommended for polyurethane coatings. Meets MIL-R-25134.

PR-3400 - methylene chloride type with no phenolic and low alcohol. Meets MIL-R-25134. Recommended for polyurethanes. Also indicated that it is approved under T.O. 1-1-8.

PR-3500 - methylene chloride type with phenolic; not ammoniated.

PR-4000 - acidic type. Not approved under any Government specification. Contains phenol but no fluorides.

PR-4041 - similar to PR-4000 but contains fluorides. This is hottest of all their strippers.

They also produce a line of strippers for the U.S. Navy as follows:

PR-3202 (an offset of PR-3200) - which meets Federal Specification TT-R-248

PR-3404 (an offset of PR-3400) - which meets Federal Specification TT-R-248

PR-3505 (an offset of PR-3500) - which meets MIL-R-81294.

Eldorado has no new products coming from their laboratory.

Possible harmful effects from methylene chloride were discussed. The Eldorado representative mentioned that he has known people who have worked with it for 20 years. He was unaware of any impairment of health. He did, however, warn that exposure of the fumes to open flames could produce phosgene, which is a very dangerous material.

An offer was made to send samples of Eldorado strippers of the phenolic and nonphenolic type.

Inland Chemical Company
Orange, California

Inland is in the process of moving all stripper-related activities from Indiana to Orange, California.

Inland supplies the following chemical strippers for aircraft:

Non-Phenolic Types

AP-599 which is approved under TO 1-1-8, and which meets MIL-R-25134B.

AP-599-AF which is claimed to be better than 599 for stripping polyurethanes. This has been submitted for approval under TO 1-1-8, but approval has not been obtained to date.

AP-548 for small commercial aircraft. It is effective for enamels and lacquers but not recommended for polyurethanes.

Phenolic Types

AP-582--neutral phenolic which meets MIL-R-81294. Used by the Navy. It has also been submitted for approval under TO 1-1-8, but has not been approved to date.

AP-587--similar to 582 except it is alkaline. Not approved even though Mr. Barrett indicates that it meets requirements of MIL-R-81294.

Acid Strippers

AP-508--non-phenolic type.
AP-561--phenolic type.

These acid strippers are used by some airline companies. As a general comment, the Inland representative indicated that phenolic strippers are more effective than non-phenolic types for removing polyurethanes and epoxies. He mentioned preference for the neutral phenolics because the ammoniated ones have very bad odor. Non-phenolics are better for lacquers and enamels.

The following samples were promised: AP 599 (approved under TO 1-1-8), AP-599 AF, AP-582, AP-508, and AP-561.

Leeder Chemical Inc.
Paramount, California

The entire line of Leeder paint strippers is based on three materials:

Leader 351-W - methylene chloride based with phenol

Leeder 666-W - methylene chloride based with no phenol alkaline (ammonium hydroxide)

Leeder 359-W - methylene chloride with phenol and organic acids (acidic type)

None of the above meet government specifications because of lack of physical compliance. For example, higher viscosity than the specification materials to prevent run-off. Performance-wise, they are claimed to meet or surpass the specification requirements.

Leeder has nothing new for testing at the present time, nor did the Leeder representative know of any significant development by other suppliers. He indicated that his major competitors are Penwalt Chemical Corporation, Turco, B&B, and Cee Bee.

McGean Chemical Company, Inc.
Miami, Florida

McGean is considered an excellent contact for several reasons: (1) McGean markets a major line of chemical strippers and cleaning materials specifically for aircraft (Cee Bee products), (2) their representative has background in aircraft stripping and he is titled an Airline Specialist, (3) National Airlines has been successfully using Cee Bee materials for several years, and (4) McGean is completely open about their product information.

Three years ago Cee Bee was absorbed by McGean Chemical who also owns Chemetron, Northwest (brighteners), and Imosa in Europe. This gives them a broad marketing base for materials used in most aspects of the aircraft industry. The company representative was formerly responsible for stripping and painting of aircraft and became aware of the special problems involved in aircraft depainting.

Cee Bee makes every effort to be open about their materials. The pH and description of each stripper is included on its data sheet. If more specific information is desired about a certain product, we should contact

Mr. W. R. Smith
Technical Director
McGean Chemical Company
Downey, California
(213) 861-1211

Moreover, a catalog of materials was promised.

This company has nothing revolutionary in the way of new product offering, nor did the Intex representative believe that anyone else has. He feels that any new product of consequence would certainly not be hidden and we would all know about it.

Pennwalt Chemical Corporation
Philadelphia, Pa.

Pennwalt is supplying a nonphenolic, methylene chloride-type paint stripper, EZ-Strip 19B, which meets MIL-R-25134A. They also supply some immersion types.

They have nothing new coming along. In fact, they are supplying only their regular customers and seeking no new business. They may eventually phase out as a supplier of aircraft paint strippers.

An offer was made to prepare a sample of 739A (made in the laboratory) for our use.

Intex Products, Inc.
Greenville, South Carolina

Intex produces the following paint strippers:

8563 - methylene chloride type (alkaline) with no phenolic.
MIL-R-25134

8562 - methylene chloride type with about 14 percent phenolic.
MIL-R-81294

Plus a Cold Tank Stripper for parts to meet MIL-R-83936, Type 3.

They currently have no new products ready for testing.

The Intex representative indicated that Intex supplies strippers to most of the air bases and commercial airlines. Major competitors mentioned are as follows: Leeder, Turco, B&B, Penwalt, and Omega (new to this market).

B & B Chemical Company
Hialeah, Florida

B & B Chemical is one of the largest manufacturers of chemical strippers in the U.S.; at least 40 strippers are sold. Their operation is kept completely secret from customers. That is, a B & B representative goes to a job site, recommends a material, and works closely with the customer. It is impossible to simply order a methylene chloride-, phenol-, or acid-type stripper because their catalog does not list materials in this manner.

It seems that B & B management feels that it is of more importance to have the B & B sales representative working for a customer than it is for the customer to know the composition of the stripping material. There was reluctance to answer any specific questions or offer any detailed information.

An offer was made to (1) send us a complete B & B catalog listing all of their stripping materials (which would be of limited value because of the product's nonchemical description) and (2) send a B & B representative to Warner Robins to conduct an on-site examination and offer suggestions to improve efficiency.